

Chapter 2 Alternatives

NEPA and CEQA require consideration of a range of alternatives to a proposed action that would feasibly attain the majority of a project's basic objectives and accomplish the project purpose and need, while avoiding or minimizing environmental impacts. The purpose of including alternatives in an EIS is to offer a clear basis for choice by decision makers and the public about whether to proceed with a proposed action or project.

NEPA requires that alternatives be evaluated at a comparable level of detail (40 Code of Federal Regulations 1502.14(b)). Similarly, the Council on Environmental Quality regulations for implementing NEPA (40 Code of Federal Regulations 1502.14) require all reasonable alternatives to be objectively evaluated in an EIS so that each alternative is evaluated at an equal level of detail. Alternatives that cannot reasonably meet the project purpose and need do not require detailed analysis.

CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified for a project in an EIR. The State CEQA Guidelines state that an EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision making and informed public participation (Section 15126.6(f)). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts, or reduce them to less-than-significant levels; alternatives considered in this context may include those that are more costly, and those that could impede, to some degree, the attainment of all the project objectives (Section 15126.6(b)). CEQA does not require the alternatives to be evaluated at the same level of detail as a proposed project.

This chapter documents compliance with NEPA requirements for alternatives analysis and the alternatives development process, and describes the six alternatives evaluated in detail in this PDEIS. This chapter is also generally consistent with CEQA requirements.

2.1 Alternatives Development Process

This section describes the alternatives development process for the SLWRI. A more detailed description of this process is included in the Plan Formulation Appendix.

2.1.1 Plan Formulation Process

The plan formulation process for Federal water resources studies and projects begins with identifying existing and projected future resources conditions likely to occur in a study area. This is followed by defining water resources problems, needs, and opportunities to be addressed, and developing planning objectives, constraints, and criteria.

For the SLWRI, the above process was separated into five phases, of which the first three have been completed. These planning phases are shown in Figure 2-1 and described below:

- **Mission Statement Phase** – This study phase consisted of projecting without-project future conditions, defining resulting resource problems and needs, defining a specific set of planning objectives, and identifying constraints and criteria for addressing the planning objectives.
- **Initial Alternatives Phase** – This phase included developing a number of potential management measures, or project actions or features designed to address planning objectives. These measures were then used to formulate a set of plans that were conceptual in scope (concept plans). These initial plans were evaluated and compared to the planning objectives to identify the most suitable plans for further development.
- **Comprehensive Plans Phase** – The measures and concept plans carried forward were further refined and developed with more specificity to formulate comprehensive alternative plans to address the planning objectives. These plans were then evaluated and compared.
- **Plan Refinement Phase** – This phase focuses on further refinement of the comprehensive plans to identify a plan suitable to be recommended for implementation. This phase includes preparing and circulating a Draft Feasibility Report and Draft EIS.
- **Recommended Plan Phase** – The next phase of the SLWRI planning process will focus on identifying a recommended plan, preparing a Biological Assessment, and confirming Federal and non-Federal responsibilities. This phase will conclude with the preparation and processing of a Final Feasibility Report to support a Federal decision, and a Final EIS.

Public and stakeholder outreach was performed concurrently with the above phases, as shown in Figure 2-1. Major reports include the *Strategic Agency Public Involvement Plan*, published in 2003 (Reclamation), and the *Environmental Scoping Report*, published in 2006 (Reclamation).

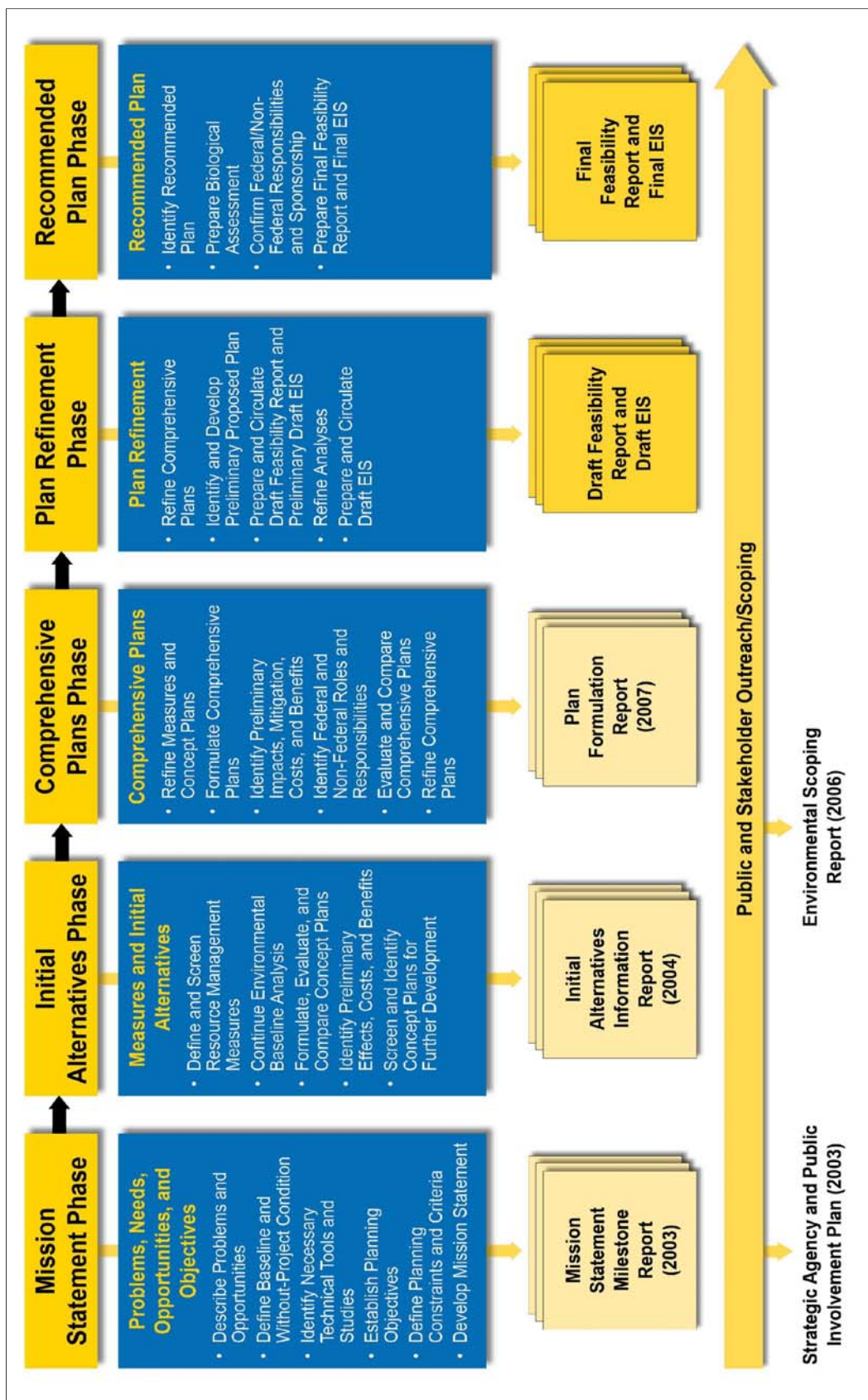


Figure 2-1. Plan Formulation Phases

2.1.2 Project Objectives

On the basis of the problems, needs, and opportunities identified in the plan formulation process, study authorities, and other pertinent direction, including information contained in the CALFED Bay-Delta Program Record of Decision (ROD) (CALFED 2000), primary and secondary objectives were developed. Primary objectives are those which specific alternatives are formulated to address. The primary objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary objectives are actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary objectives.

- **Primary Objectives:**
 - Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the Red Bluff Diversion Dam (RBDD)
 - Increase water supply and water supply reliability for agricultural, municipal and industrial (M&I), and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir
- **Secondary Objectives:**
 - Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River
 - Reduce flood damage along the Sacramento River
 - Develop additional hydropower generation capabilities at Shasta Dam
 - Maintain and increase recreation opportunities at Shasta Lake
 - Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta

Criteria, constraints, and additional planning considerations used to guide alternatives formulation are described in the Plan Formulation Appendix.

Following development of objectives, constraints, and criteria for the SLWRI, the next major step in formulating concept plans was to identify and evaluate potential management measures.

2.1.3 Management Measures

A management measure is any structural or nonstructural project action or feature that could address the objectives and satisfy the other applicable planning considerations. Numerous potential management measures were identified based on previous studies, programs, and projects to address the objectives. These measures were developed through study team meetings, field inspections, outreach, and environmental scoping for the SLWRI. Management measures are listed in Table 2-1 and described in detail in the Plan Formulation Appendix.

In the context of SLWRI management measures and project actions, the term “enhancement” specifically refers to restoration actions that improve environmental conditions above the baseline (without-project condition). Correspondingly, the term “mitigation” refers to restoration actions that improve environmental conditions toward the baseline to compensate for project impacts. The relationship between restoration, enhancement, and mitigation is illustrated in Figure 2-2.

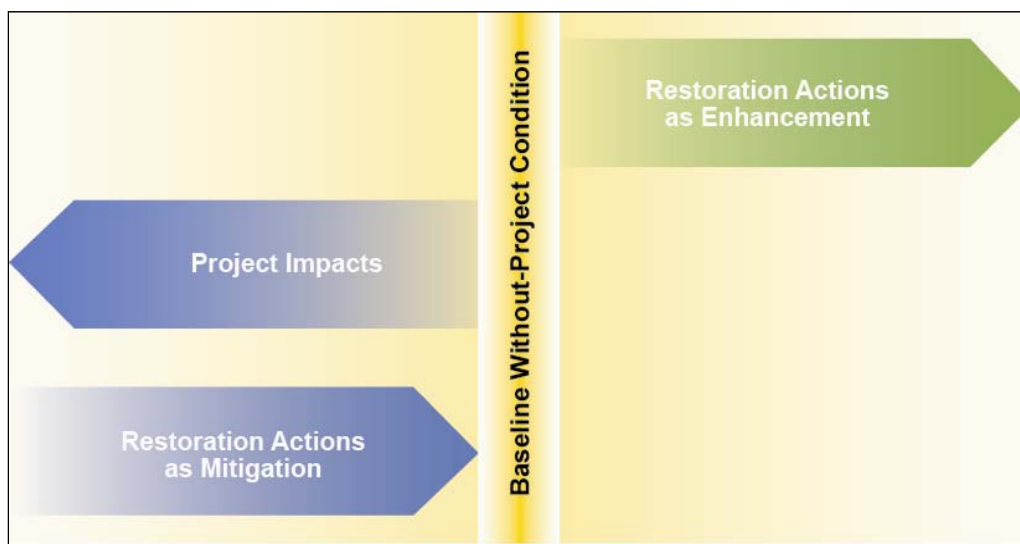


Figure 2-2. Conceptual Schematic of Restoration Actions as Enhancement Versus Restoration Actions as Mitigation

Table 2-1. Management Measures to Address Objectives

Objectives		Management Measure	Retained	Deleted
Primary Objectives				
Increase Anadromous Fish Survival	Improve Fish Habitat	Restore abandoned gravel mines along the Sacramento River		X
		Construct instream aquatic habitat downstream from Keswick Dam	X	
		Replenish spawning gravel in the Sacramento River	X	
	Improve Water Flows and Quality	Construct instream fish habitat on tributaries to the Sacramento River		X
		Remove instream sediment along Middle Creek		X
		Rehabilitate inactive instream gravel mines along Stillwater and Cottonwood creeks		X
		Make additional modifications to Shasta Dam for temperature control	X	
		Enlarge Shasta Lake cold-water pool	X	
	Improve Fish Migration	Modify storage and releases operations at Shasta Dam	X	
		Modify ACID diversions to reduce flow fluctuations		
		Increase instream flows on Clear, Cow, and Bear creeks		X
		Construct a storage facility on Cottonwood Creek to augment spring instream flows		X
		Transfer existing Shasta Reservoir storage from water supply to cold-water releases		X
		Remove Shasta Dam and Reservoir		X
		Improve fish trap below Keswick Dam		X
Increase Water Supply Reliability	Increase Surface Water Storage	Screen diversions on Old Cow and South Cow creeks		X
		Remove or screen diversions on Battle Creek		X
		Construct a migration corridor from the Sacramento River to the Pit River		X
		Cease operating or remove the Red Bluff Diversion Dam		X
		Reoperate the CVP to improve overall fish management		X
		Construct a fish ladder on Shasta Dam		X
		Reintroduce anadromous fish to areas upstream from Shasta Dam		X
		Increase conservation storage space in Shasta Reservoir by raising Shasta Dam	X	
		Construct new conservation storage reservoir(s) upstream from Shasta Reservoir		X
		Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam		X
		Construct new conservation offstream surface storage near the Sacramento River downstream from Shasta Dam		
		Construct new conservation surface water storage south of the Delta		X
		Increase total or seasonal conservation storage at other CVP facilities		X
		Dredge bottom of Shasta Reservoir		X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives	Management Measure	Retained	Deleted
Increase Water Supply Reliability (continued)	Reoperate Reservoir	X	
			X
			X
	Improve Conjunctive Water Management		X
			X
			X
	Coordinate Operation and Precipitation Enhancement		X
	Reduce Demand	X	
			X
	Improve Water Transfers and Purchases		X
	Expand Delta Export and Conveyance Facilities		X
	Improve Surface Water Treatment		X
			X
			X
			X
			X
			X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives	Management Measure	Retained	Deleted
Improve Cold-Water and Warm-Water Fishery Habitat Restore and Conserve Riparian and Wetland Habitat Improve Other Fish and Wildlife Habitat Reduce Flood Damage	Secondary Objectives		
	Construct shoreline fish habitat around Shasta Lake	X	
	Construct instream fish habitat on tributaries to Shasta Lake	X	
	Increase instream flows on the lower McCloud River		X
	Reduce acid mine drainage entering Shasta Lake		X
	Reduce motorcraft access to upper reservoir arms		X
	Increase instream flows on the Pit River		X
	Restore riparian and floodplain habitat along the Sacramento River	X	
	Restore wetlands along the Fall River and Hat Creek		X
	Conserve upper Pit River riparian areas		X
	Restore riparian and floodplain habitat on lower Clear Creek		X
	Promote Great Valley cottonwood regeneration along the Sacramento River		X
	Conserve riparian corridor along Cow Creek		X
	Remove and control nonnative vegetation in the Cow Creek and Cottonwood Creek watersheds		X
	Create a parkway along the Sacramento River		X
	Enhance forest management practices to conserve bald eagle nesting habitat		X
	Remove and control nonnative plants around Shasta Lake		X
	Control erosion and restore affected habitat in the Shasta Lake area		X
	Develop geographic information system for Shasta to Red Bluff reach		X
	Implement erosion control in tributary watersheds		X
	Update Shasta Dam and Reservoir flood management operations	X	
	Increase flood management storage space in Shasta		X
	Implement nonstructural flood damage reduction measures		X
	Implement traditional flood damage reduction measures		X
	Route PMF from top of conservation pool		X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives	Management Measure	Retained	Deleted
Develop Additional Hydropower Generation	Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased hydraulic head	X	
	Construct new hydropower generation facilities		X
	Maintain and enhance recreation capacity, facilities, and opportunities	X	
Maintain and Increase Recreation Opportunities	Develop new NRA recreation plan		X
	Reoperate reservoir for recreation	X	
Maintain or Improve Water Quality	Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir	X	

Key:

ACID = Anderson-Cottonwood Irrigation District
 Banks Pumping Plant = Harvey O. Banks Pumping Plant
 CVP = Central Valley Project
 Delta = Sacramento-San Joaquin Delta
 NRA = National Recreation Area
 PMF = probable maximum flood
 SWP = State Water Project

The SLWRI study team and stakeholders reviewed the management measures for their ability to address the primary and secondary objectives. Retained management measures were combined to formulate concept plans. As detailed in the Plan Formulation Appendix, measures are retained for possible inclusion in an alternative plan or deleted from further consideration for various reasons. One important factor for retention in alternative plans is the potential for a measure to directly address an objective without adversely impacting other objectives.

Of the management measures listed in Table 2-1, eight measures addressing primary objectives were selected for further consideration and potential inclusion in alternative plans. Eight measures addressing secondary objectives were also selected for potential inclusion in alternative plans. Measures that have been carried forward are believed to best address the objectives of the SLWRI, with consideration of planning constraints and criteria. It should be noted that measures that have been deleted from consideration in this phase may be reconsidered in the future as mitigation measures.

2.1.4 Initial Alternatives Phase

The retained measures were used to formulate a preliminary set of plans that were conceptual in scope. Each concept plan was reviewed for impacts, costs, and benefits and compared to objectives to determine whether the plan should be eliminated or carried forward into the comprehensive plans phase. The purpose of this phase of the formulation process was to (1) explore an array of different strategies to address the primary objectives, constraints, and criteria, and (2) identify concept plans that would warrant further development in the comprehensive plans phase.

First, two sets of plans were developed that focused on either anadromous fish survival (AFS) or water supply reliability (WSR) as the single primary objective. Three AFS plans and four WSR plans were developed. Although the AFS and WSR plans focused on single objectives, each generally contributed to both primary objectives. In the three AFS plans, for example, emphasis was placed on combinations of measures that could best address the fish survival goals while considering incidental benefits to water supply reliability, if possible. Second, five plans were developed that included measures to address both primary and, to a lesser degree, secondary objectives, termed combined objective (CO) plans. All 12 concept plans are listed in Table 2-2, and are explained in detail in the Plan Formulation Appendix.

Table 2-2. Summary of Concept Plan Features

Plan	Features													
	Dam Raise	Primary Objective Focus							Secondary Objectives Addressed ⁴					
		Water Supply Reliability ²			Anadromous Fish Survival				Environmental Restoration			Flood Control and Hydropower		Recreation
		Raise Shasta Dam ¹ (feet)	Increase Conservation Storage	Perform Conjunctive Water Management ³	Reoperate Shasta Dam	Modify TCD	Replenish Spawning Gravel	Enlarge Shasta Lake Cold-Water Pool	Increase Minimum Flows ³	Restore Shoreline Aquatic Habitat	Restore Tributary Aquatic Habitat	Restore Riparian Habitat	Modify Flood Control Operations and Implement Shasta Public Safety ³ Features	
AFS-1	6.5	*		Changes to water supply operations and modification of the TCD would likely be included, to some extent, in any alternative that includes raising Shasta Dam.			X					Changes to flood control operations at Shasta Dam, Public Safety, ³ and hydropower facilities would likely be part of any alternative that includes physically modifying Shasta Dam; the degree and details of these changes will be included in feasibility level alternative plans.	Maintain and Increase Recreation Opportunities	
AFS-2	6.5	*					*	X						
AFS-3	6.5	*				X	*	X						
WSR-1	6.5	X					*							
WSR-2	18.5	X					*							
WSR-3	202.5	X					*							
WSR-4	18.5	X	X				*							
CO-1	6.5	X					X	X						
CO-2	18.5	X					X	X						
CO-3	18.5	X					X	X	X					
CO-4	6.5	X	X				X	X		X	X			X
CO-5	18.5	X	X			X	X		X	X	X			

Notes:

¹ Raising Shasta Dam provides both water supply and temperature benefits, regardless of how the additional storage is exercised. While the AFS measures focus on use of the additional space for anadromous fish survival, they also provide water supply benefits. Similarly, the WSR measures focus on water supply reliability but the reservoir enlargements also provide benefits to anadromous fish.

² All concept plans will include attention to water demand reduction.

³ These measures were used for evaluation because they were retained at the time of plan formulation. However, they have since been removed from consideration.

⁴ Water quality was added as a management measure after development of concept plans, and is not considered in this table.

Key:

* Coincidental benefit, although not a primary focus of the concept plan.

AFS = anadromous fish survival

CO = combined objectives

TCD = temperature control device

WSR = water supply reliability

X = Primary focus of concept plan

The 12 concept plans were compared considering two basic planning criteria: effectiveness and efficiency. Effectiveness is the extent to which an alternative alleviates problems and achieves objectives; efficiency is the measure of how efficiently an alternative alleviates identified problems and meets specified objectives to protect the Nation's environment. These, along with completeness and acceptability, are the four general criteria identified in the *Federal Water Resources Council Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983). Based on this comparison, and the relative ability of plans to address both primary objectives, five of the concept plans were initially recommended for further development as comprehensive plans (CP): WSR-1, WSR-2, WSR-4, CO-2, and CO-5. CO-2 was subsequently eliminated from further consideration because continued evaluation concluded that restoration of existing gravel mines would have a low likelihood of successfully benefiting salmon resources. Subsequent analysis of WSR-4 and the conjunctive use component of CO-5 indicated tradeoffs between conjunctive use water supply benefits and critical gains in fisheries benefits. The resulting reduction in benefits to fisheries operations in dry and critical years was deemed unacceptable in terms of meeting primary project objectives. Thus, WSR-4 and the conjunctive use component of CO-5 were eliminated from further consideration.

The eight concept plans eliminated from further consideration are described in Section 2.2, "Alternatives Considered and Eliminated from Further Consideration." Although these concept plans were not further considered as stand-alone plans, major features of some of these plans were refined for further development into alternatives. Concept plans eliminated from further consideration, and rationale for their elimination, are discussed in detail in the Plan Formulation Appendix.

2.1.5 Development and Refinement of Comprehensive Plans

Through continued refinement of management measures and concept plans carried forward, the following plan types were identified for further development into comprehensive plans:

- Plan(s) to raise Shasta Dam between 6.5 feet and 18.5 feet, focusing on both water supply reliability and anadromous fish survival but with benefits to various secondary objectives (subsequently developed into CP1, CP2, and CP3)
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on anadromous fish survival, but also including water supply reliability and other various secondary objectives (subsequently developed into CP4)
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on all objectives (subsequently developed into CP5)

Considering results of initial plan formulation efforts, the approach was to first formulate plans focusing on different dam raise heights within the range of 6.5 to 18.5 feet to address the first plan type listed above. A dam raise of 12.5 feet in CP2 was chosen because it represented a midpoint between the smallest and largest likely and practical dam raises. Next, the approach was to identify the most efficient and effective of the identified dam raise heights, and formulate comprehensive plans to focus on anadromous fish survival and other objectives at this height.

Using the general rationale described above, and incorporating input from the public scoping process and continued coordination with resource agencies and other interested parties, five comprehensive plans were developed in addition to the No-Action Alternative:

- **Comprehensive Plan 1 (CP1)** — 6.5-foot dam raise, enlarging the reservoir by 256,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **Comprehensive Plan 2 (CP2)** — 12.5-foot dam raise, enlarging the reservoir by 443,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **Comprehensive Plan 3 (CP3)** — 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **Comprehensive Plan 4 (CP4)** — 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on anadromous fish survival while increasing water supply reliability.
- **Comprehensive Plan 5 (CP5)** — 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, a combination plan focusing on all objectives.

The five comprehensive plans were designated as the action alternatives for the purpose of this PDEIS, and are described in Section 2.4.

Because of the large number of possibilities for increasing anadromous fish survival, additional analyses were conducted to determine the combination of actions that would provide the greatest overall benefits within CP4. These analyses are described below.

Refinement of Plan for Anadromous Fish Survival Focus with Water Supply Reliability

Primarily using the SALMOD model, and based on output from the water operations (CalSim-II), reservoir temperature, and river temperature models, a suite of flow- and temperature-focused actions (scenarios) were investigated to

assess which combination of actions would likely result in the maximum increase in fish populations.

To formulate CP4, three dam height raises were considered (6.5 feet, 12.5 feet, and 18.5 feet), resulting in 256,000 acre-feet, 443,000 acre-feet, and 634,000 acre-feet of increased storage, respectively. For each of these proposed dam raises, several combinations for allocating the increased storage were analyzed. For instance, assuming a dam raise of 12.5 feet, three options were considered: (1) no increase in the minimum pool, (2) an increase in the minimum pool similar to a 6.5-foot dam raise, and (3) all of the increased space dedicated to increased fisheries. The combinations considered represent scenarios developed to focus on increasing the cold-water pool, and are listed in Table 2-3.

Table 2-3. Scenarios Considered for Cold-Water Storage – Anadromous Fish Survival Focus with Water Supply Reliability

Scenario	Dam Raise (feet)	Enlarged Reservoir	Description
A (CP1)	6.5	256,000 acre-feet	No increase in minimum pool.
B	6.5	256,000 acre-feet	Dedicate 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.
C (CP2)	12.5	443,000 acre-feet	No increase in minimum pool.
D	12.5	443,000 acre-feet	Dedicate 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
E	12.5	443,000 acre-feet	Dedicate 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.
F (CP3/CP5)	18.5	634,000 acre-feet	No increase in minimum pool.
G	18.5	634,000 acre-feet	Dedicate 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
H (CP4)	18.5	634,000 acre-feet	Dedicate 378,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
I	18.5	634,000 acre-feet	Dedicate 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.

Key:
CP = comprehensive plan

Additional scenarios focusing on increasing Sacramento River flows with an 18.5-foot raise were also analyzed. The flow combinations were based primarily on flows identified as part of the Anadromous Fish Restoration Plan (USFWS 2001). These scenarios are listed in Table 2-4.

Table 2-4. Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan

Flow Augmentation Scenario	Dam Raise (feet)	Enlarged Reservoir	Description
1	18.5	634,000 acre-feet	October – March AFRP flows or 500 cfs increase, whichever is less.
2	18.5	634,000 acre-feet	October – March AFRP flows or 750 cfs increase, whichever is less.
3	18.5	634,000 acre-feet	October – March AFRP flows or 1,000 cfs increase, whichever is less.
4	18.5	634,000 acre-feet	Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control.

Key:
AFRP = Anadromous Fish Restoration Plan (USFWS 2001)
cfs = cubic foot per second

Quantitative analysis indicated that increasing the minimum pool in Shasta Reservoir would have the greatest net fishery benefit. By increasing the minimum pool, the allowable carryover pool storage would increase in the reservoir. This carryover would act to conserve cold water that could be managed to better benefit anadromous fish. Scenarios 1, 2, 3, and 4 (flow augmentation scenarios) showed limited benefits to anadromous fish compared with other scenarios, and were eliminated from further analysis. Scenarios B, E, and I would not contribute to increased water supply reliability. Although CP4 focuses on anadromous fish survival, because these three scenarios would not contribute to a primary objective, they were deleted from further consideration. Of the remaining scenarios, Scenarios D and H were deemed to be the most cost-effective. Based on further analysis, Scenario H was chosen to represent reservoir operations in CP4 because this scenario would provide the greatest benefit to anadromous fish and still meet the primary objective of water supply reliability. Scenario comparison and selection are discussed further in the Plan Formulation Appendix.

2.2 Alternatives Considered and Eliminated from Further Analysis

Alternatives considered but eliminated from further analysis are described below. Plans are described that were developed during the initial plans phase, and the comprehensive plans phase, consistent with the alternatives development process discussed above. Management measures deleted from further consideration were summarized previously and are also described in the Plan Formulation Appendix.

2.2.1 Initial Alternatives Phase

The following concept plans were eliminated from further consideration as stand-alone plans.

- **AFS-1**– Increase Cold Water Assets with Shasta Operating Pool Raise (6.5 feet). AFS-1 focused on maintaining cooler water temperatures in the upper Sacramento River by increasing the minimum end-of-October carryover storage target. This would allow additional cold water to be stored for use in the following year. No changes would be made to the existing seasonal temperature targets for anadromous fish on the upper Sacramento River, but the ability to meet these targets would be improved. It was found that this plan had a significant potential to benefit anadromous fish in the upper Sacramento River, but there would be no additional increase in water supply reliability. Major plan components included (1) raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the cold-water pool and regulating water temperature in the upper Sacramento River and (2) increasing the size of the minimum operating pool to 880,000 acre-feet. This plan was not retained for further development as a stand-alone plan because, although it had considerable benefits for anadromous fish survival, it did not meet the primary planning objective of increasing water supply reliability.
- **AFS-2** – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet). AFS-2 focused on the primary planning objective of anadromous fish survival by using the additional reservoir storage to increase minimum seasonal flows in the upper Sacramento River from the current 3,250 cubic feet per second (cfs) to about 4,200 cfs. The primary component of AFS-2 included raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River. No changes would be made to the carryover target volume or minimum operating pool. Subsequent evaluation indicated that although at various stages of development the concept of increasing minimum flows would be beneficial for fish, at other life stages increasing minimum flows would be detrimental. Accordingly, this plan was deleted from further development.
- **AFS-3** – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet) and Restore Aquatic Habitat. AFS-3 was similar to AFS-2, except that it also includes acquiring, restoring, and reclaiming one or more inactive gravel mine along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat. Major plan components included (1) raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River and (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat. Increasing minimum flows was not found to significantly benefit to anadromous fish, and concerns were expressed

regarding significant uncertainties about offstream areas being able to successfully support viable fish spawning and rearing. Further, during public scoping activities in late 2005, little to no interest was demonstrated for restoring inactive gravel mines along the Sacramento River above the RBDD. Accordingly, this plan element was deleted from further consideration at this time.

- **WSR-3** – Increase Water Supply Reliability with Shasta Enlargement (High Level). WSR-3 focused on water supply reliability by increasing the volume of water stored in Shasta Lake by the maximum amount technically feasible. Major components of this plan included (1) raising Shasta Dam by about 202.5 feet for the primary purpose of creating 9.3 million acre feet (MAF) of additional storage available for water supply and (2) major modifications to, or replacing, dam appurtenances, including hydropower facilities and the temperature control device (TCD). Raising the dam to this level would require extensive and very costly reservoir area relocations such as moving the Pit River Bridge, Interstate-5 (I-5), and the Union Pacific Railroad, and would require modifying Keswick Dam and its powerplant. This plan would provide a major increase in water supply reliability, anadromous fish, hydropower, flood damage reduction, and recreation resources. However, the plan is not financially feasible at this time because the construction cost is estimated at over \$6 billion (at October 2008 price levels). Accordingly, this plan was deleted from further development.
- **WSR-4** – Increase Water Supply Reliability with Shasta Enlargement (18.5 feet) and Conjunctive Water Management. WSR-4 focused on the primary objective of water supply reliability by raising Shasta Dam 18.5 feet in combination with conjunctive water management. Major components of this plan included (1) raising Shasta Dam by 18.5 feet for the primary purpose of creating 636,000 acre-feet of additional storage available for water supply and (2) implementing a conjunctive water management program, consisting largely of contracts between Reclamation and certain Sacramento River basin water users. The conjunctive water management component included downstream facilities, such as additional river diversions and transmission and groundwater pumping facilities, to facilitate exchanges. Reclamation would provide additional surface supplies in wet and normal water years to participating CVP users, in exchange for reducing deliveries in dry and critically dry years, when users would rely more on groundwater supplies. Preliminary estimates of the conjunctive water management component associated this alternative indicated that water supply yield could be increased between 10 to 20 percent. However, few to no fishery benefits would result and no strong indication of non-Federal participation in a conjunctive water management component was identified. Accordingly, this plan element was deleted from further consideration.

- **CO-1 and CO-2** – Increase Anadromous Fish Habitat and Water Supply Reliability with Shasta Enlargement (6.5 feet and 18.5 feet). CO-1 and CO-2 addressed both primary objectives by restoring anadromous fish habitat and raising Shasta Dam. Both CO-1 and CO-2 would dedicate some of the added reservoir space from the dam raise to increasing the minimum carryover storage in Shasta Reservoir to make more cold-water releases for regulating water temperature in the upper Sacramento River. Major components of this plan included (1) raising Shasta Dam by 6.5 feet and 18.5 feet, respectively, for the purposes of expanding the cold-water pool and creating 260,000 acre-feet and 630,000 acre-feet, for CO-1 and CO-2, respectively, of additional storage available for water supply, (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to create about 150 acres of aquatic and floodplain habitat, and (3) revising flood control operations to benefit water supply reliability by managing floods more efficiently. For reasons similar to those described for AFS-3, both CO-1 and CO-2 were eliminated as stand-alone plans and the gravel mine restoration components of both plans were deleted from further consideration.
- **CO-3** – Increase Anadromous Fish Flow/Habitat and Water Supply Reliability with Shasta Enlargement (18.5 feet). CO-3 is similar to CO-2, except a portion of the additional storage would be dedicated to managing flows for winter-run Chinook salmon on the upper Sacramento River. Under this preliminary plan, approximately 320,000 acre-feet would be dedicated to increasing minimum flows from approximately 3,250 cfs to about 4,200 cfs between October 1 and April 30. However, subsequent evaluation indicated that although at various stages of development the concept of increasing minimum flows would be beneficial for fish, at other life stages increasing minimum flows would be detrimental. Accordingly, this plan was deleted from further development.
- **CO-4** – Multipurpose with Shasta Enlargement (6.5 feet). This plan addressed both primary and secondary objectives through a combination of measures, including raising Shasta Dam, restoring habitat, and adding recreation facilities in the Shasta Lake area. Enlargement of the reservoir and limited reservoir reoperation would also help improve operations for flood management and recreation. Major components of this plan included increasing water supply reliability with a 6.5-foot dam raise, increasing anadromous fish survival by increasing cold-water pool depth and volume in Shasta Reservoir, and restoring inactive gravel mines and floodplain habitat along the Sacramento River. In addition, the plan included further investigation of and potential modifications to the existing TCD at Shasta Dam for enhanced temperature management, and increasing the operational efficiencies of Shasta Dam and Reservoir for water supply

reliability and flood control. Finally, the plan included implementing conjunctive water management, as in WSR-4, shoreline and tributary fish habitat improvements in the Shasta Lake area, and restoring one or more riparian habitat areas between Redding and Red Bluff on the Sacramento River. CO-4 was eliminated from further consideration primarily because of low effectiveness and efficiency and redundancies with WSR-1 and CO-5, both of which were recommended for further development.

2.2.2 Comprehensive Plans Phase

The scenarios presented in Tables 2-5 and 2-6 were eliminated from further consideration during the comprehensive plans phase. These scenarios are described further in the Plan Formulation Appendix.

Table 2-5. Eliminated Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan

Scenario	Description	Reason for Elimination
1	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 500 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
2	Dam raise of 18.5-feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 750 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
3	Dam raise of 18.5-feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 1,000 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
4	Dam raise of 18.5-feet. Additional 634,000 acre-feet of storage. Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control.	Analysis indicated limited benefits to fish compared with overall cost of the project.

Source: USFWS 2001

Key:

AFRP = Anadromous Fish Restoration Plan

cfs = cubic feet per second

**Table 2-6. Eliminated Scenarios Considered for Cold-Water Storage –
Anadromous Fish Survival Focus Plan**

Scenario	Description	Reason for Elimination
B	Dam raise of 6.5 feet. Additional 256,000 acre-feet of storage. Dedicating 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
D	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it was not as cost-effective as an 18.5-foot raise.
E	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
G	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Dedicating 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it was redundant with Scenario H and provided less benefit.
I	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Dedicating 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.

2.3 No-Action Alternative

NEPA and CEQA require the analysis of a baseline alternative, representing a scenario in which the project is not implemented. For all Federal feasibility studies of potential water resources projects, the NEPA No-Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete.

Under CEQA, the No-Project Alternative is similar to NEPA's No-Action Alternative, but it involves the review of two scenarios: the existing condition baseline, which represents only current conditions at the time the Notice of Preparation is published, and "reasonably foreseeable" future conditions without the project (which is equivalent to the NEPA No-Action Alternative). Table 2-1 of the Modeling Appendix describes the existing condition, and shows which actions were assumed to be part of the future condition (or No-Action /No-Project Alternative).

For the PDEIS, the No-Action Alternative is considered to be the basis for comparison with potential action alternatives, consistent with the *Federal Water Resources Council Principles and Guidelines for Water and Related Land*

Resources Implementation Studies (WRC 1983) and NEPA guidelines. Thus, if no proposed action is determined to be feasible, the No-Action Alternative is the default option.

Plan formulation efforts and analysis of the No-Action Alternative and action alternatives discussed in this chapter are based on CVP and SWP operational conditions described in the 2004 Operations Criteria and Plan Biological Assessment (Reclamation 2004). Modeling studies will be updated to reflect changes in water operations resulting from ongoing Operations Criteria and Plan reconsultation and other relevant water resources projects and programs, including, potentially, Bay-Delta Conservation Plan/Delta Habitat Conservation and Conveyance Plan efforts. The results of these updated studies will be incorporated into the Draft EIS and other future SLWRI documents.

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, as defined above, but would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California. The following discussions highlight the consequences of implementing the No-Action Alternative, as they relate to the objectives of the SLWRI.

2.3.1 Anadromous Fish Survival

Much has been done to address anadromous fish survival problems in the upper Sacramento River. Solutions have ranged from changes in the timing and magnitude of releases from Shasta Dam to constructing and operating the TCD at the dam. Actions also include site-specific projects, such as introducing spawning gravel to the Sacramento River, and work to improve or restore spawning habitat in tributary streams. However, some actions have had an adverse effect on Sacramento River habitat, including implementing requirements of the Trinity River ROD, as amended (Reclamation 2000), which reduced flows from the Trinity River basin into Keswick Reservoir and then into the Sacramento River. Water diverted from the Trinity River is generally cooler than flows released from Shasta Dam. Accordingly, since implementation of the Trinity ROD, some of the benefits derived from flow changes and the Shasta TCD have been offset by the reduction in cooler water from the Trinity River. Increased demand for water for agricultural, M&I, and environmental uses is also expected to reduce the reliability of cold water for anadromous fish. Prolonged drought that depletes the cold-water pool in Shasta Reservoir could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term (NMFS 2009). The risk associated with a prolonged drought is especially high in the Sacramento River because Shasta Reservoir is operated to maintain only 1 year of carryover storage. Under the No-Action Alternative, after 2 years of drought, Shasta Reservoir storage would be insufficient to provide cold water throughout the winter-run Chinook salmon spawning season. A drought lasting several years would likely result in the extirpation of winter-run Chinook salmon (NMFS 2009).

Under the No-Action Alternative, it is assumed that actions to protect fisheries and benefit aquatic environments would continue, including maintaining the TCD and satisfying existing regulatory requirements.

2.3.2 Water Supply Reliability

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow. There is growing competition for limited system resources between various users and uses, including agricultural, M&I, and environmental. M&I water demands and environmental water requirements have each increased, resulting in greater competition for limited water supplies. As mentioned, the population of California is expected to increase by more than 60 percent above 2005 levels by 2050. Significant increases in population also are expected to occur in the Central Valley, nearly 130 percent above 2005 levels by 2050. As these population increases occur, and are coupled with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for water would continue to significantly exceed available supplies. Competition for available water supplies would intensify as water demands increase to support this population growth.

Water conservation and reuse efforts are expected to significantly increase, and forced conservation resulting from increasing water shortages would continue. Without developing cost-effective new sources, however, the growing urban population would increasingly rely on shifting water supplies from such areas as agricultural production to satisfy M&I demands. It is likely that with continued and deepening shortages in available water supplies, adverse economic impacts would increase over time in the Central Valley and elsewhere in California. One example could include higher water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the United States. Under the No-Action Alternative, Shasta Dam would not be modified and the CVP would continue operating similarly to existing conditions.

The No-Action Alternative would continue to meet water supply demands at levels similar to existing conditions, but would not be able to meet the expected increased demand in California.

2.3.3 Ecosystem Resources, Flood Management, Hydropower Generation, Recreation, and Water Quality

As opportunities arise, some locally sponsored efforts would likely continue to improve environmental conditions on tributaries to Shasta Lake and along the upper Sacramento River. However, overall, future environmental-related conditions in these areas would likely be similar to existing conditions. The quantity, quality, diversity, and connectivity of riparian, wetland, and riverine habitats along the Sacramento River have been limited by confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development.

Shasta Dam and Reservoir have greatly reduced flood damage along the Sacramento River. Shasta Dam and Reservoir were constructed at a total cost of about \$36 million. During flood events in 1983, 1986, and 1997, Shasta Dam, in combination with the Sacramento River Flood Control Project, prevented an estimated \$14 billion in property losses due to flooding. Accordingly, from a flood damage perspective only, Shasta Dam has far more than paid for itself. However, residual risks to human life, health, and safety along the Sacramento River remain. Development in flood-prone areas has exposed the public to the risk of flooding. Storms producing peak flows, and volumes greater than the existing flood management system was designed for, can occur, and result in extensive flooding along the upper Sacramento River. Under the No-Action Alternative, the threat of flooding would continue, and may increase as population growth continues.

California's demand for electricity is expected to significantly increase in the future. Under the No-Action Alternative, no actions would be taken to help meet this growing demand.

As California's population continues to grow, demands would grow significantly for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand would be especially pronounced at Shasta Lake.

To address the impact of water quality deterioration on the Sacramento River basin and Delta ecosystems and endangered and threatened fish populations, several environmental flow goals and objectives in the Central Valley (including the Delta) have been established through legal mandates aimed at maintaining and recovering endangered and threatened fish and wildlife, and protecting designated critical habitat. Despite these efforts, under the No-Action Alternative, these resources would continue to decline and ecosystems would continue to be impacted. In addition, Delta water quality may continue to decline.

2.4 Action Alternatives

The five comprehensive plans designated as the action alternatives for the purpose of this PDEIS are discussed below. Management measures, construction activities, and environmental commitments common to these alternatives are described first.

2.4.1 Management Measures Common to All Action Alternatives

Eight of the management measures retained during the alternatives development process are included, to some degree, in all of the action alternatives. These measures were included because they (1) would either be incorporated or required with any dam raise, (2) were logical and convenient additions that would significantly improve any alternative, or (3) should be considered with

any new water increment developed in California. The eight measures include enlarging the Shasta Lake cold-water pool, modifying the TCD, increasing conservation storage, reducing demand, modifying flood operations, modifying hydropower facilities, maintaining or increasing recreation opportunities, and maintaining or improving water quality.

Enlarge Shasta Lake Cold-Water Pool

Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. At a minimum, all comprehensive plans include enlarging the cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir. Some alternatives also increase the seasonal carryover storage in Shasta Lake.

Modify Temperature Control Device

For all action alternatives, the TCD would be modified to account for an increased dam height and to reduce leakage of warm water into the structure. Minimum modifications to the TCD include raising the existing structure and modifying the shutter control. This measure would increase the ability of operators at Shasta Dam to meet downstream temperature requirements, and provide more operational flexibility to achieve desirable water temperatures during critical periods for anadromous fish.

Increase Conservation Storage

All action alternatives include increasing the amount of space available for water conservation storage in Shasta Reservoir by raising Shasta Dam. Conservation storage is the portion of the reservoir capacity available to store water for subsequent release to increase water supply reliability for agricultural, M&I, and environmental purposes. All action alternatives include a range of dam enlargements and increases in conservation space.

Reduce Demand

All action alternatives include a water conservation program for new water supplies that are created by the project. This program would augment current water use efficiency practices. The proposed program would consist of a 10-year initial program to which Reclamation would allocate approximately \$2.3 million to \$3.8 million to fund water conservation efforts. Funding would be proportional to additional water supplies delivered and would focus on assisting project beneficiaries (agencies receiving increased water supplies because of the project), with developing new or expanded urban water conservation, agricultural water conservation, and water recycling programs. Program actions would be a combination of technical assistance, grants, and loans to support a variety of water conservation projects such as recycled wastewater projects, irrigation system retrofits, and urban utilities retrofit and replacement programs. The program could be established as an extension of existing Reclamation programs, or as a new program through teaming with SLWRI cost-sharing partners. Combinations and types of water use efficiency actions funded would be tailored to meet the needs of identified cost-sharing partners, including

consideration of cost-effectiveness at a regional scale for agencies receiving funding.

Modify Flood Operations

Physical enlargement of Shasta Reservoir would require alterations to existing flood operation guidelines or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation. The rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible. Potential modification of flood operations would be considered for all action alternatives.

Modify Hydropower Facilities

Under each action alternative, physical enlargement of Shasta Dam would likely require various minimum modifications, commensurate with the magnitude of the enlargement, to the existing hydropower facilities at the dam to enable their continued efficient use. These modifications, in conjunction with increased lake surface elevations, may provide incidental benefits to hydropower generation. Although modifications could also be included to further increase the power production capabilities of the reservoir (e.g., additional penstocks and generators), they are believed to be a detail beyond the scope of this investigation and are not considered further at this level of planning.

Maintain and Increase Recreation Opportunities

In addition to the measures described above, all action alternatives address, to some extent, the secondary objective of maintaining or increasing recreation opportunities at Shasta Lake. Outdoor recreation, and especially recreation at Shasta Lake, represents a major source of enjoyment to millions of people annually and is a major source of income to the northern Sacramento Valley. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Recreation within these lands is managed by USFS. As part of this administration, USFS either directly operates and maintains, or manages through leases, numerous public campgrounds, marinas, boat launching facilities, and related water-oriented recreation facilities. Enlarging Shasta Dam and Reservoir would affect some of these facilities. Consistent with the position of USFS, and planning conditions described in this chapter, all of the action alternatives include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. All action alternatives also provide for modernization of recreation facilities.

Maintain or Improve Water Quality

All action alternatives could contribute to improved Delta water quality conditions and Delta emergency response. Additional storage in Shasta Reservoir would provide improved operational flexibility. Shasta Dam has the ability to provide increased releases and high-flow releases to reestablish Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially

increasing Delta outflow during drought years and reducing salinity during critical periods.

2.4.2 Construction Activities Common to All Action Alternatives

Common construction activities would include land-based construction activities associated with the following:

- Clearing vegetations from portions of the inundated reservoir area.
- Constructing the dam, appurtenant structures, reservoir area dikes, and railroad embankments.
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure.

Construction activities common to all action alternatives are described below.

Clearing Portions of Inundated Reservoir Area

A portion of the acreage inundated at the new full pool would need to be cleared. This would include removing trees and other vegetation from around the reservoir. Willows, cottonwoods, and buttonbush would not be removed in and along riparian areas. Manzanita removed in cleared areas would be stockpiled and used for fish habitat structures placed in designated locations. Structures, utilities, and other infrastructure would also need to be removed and/or relocated, as described below in more detail.

Fifteen vegetation management areas have been delineated to facilitate efficient removal of vegetation around the reservoir perimeter, including 11 areas of complete vegetation removal and 4 areas of overstory removal (see Figure 2-3). The acreages of each vegetation management area affected by identified reservoir clearing treatments are included below in the detailed description of each action alternative.

Vegetation management activities would need to be complete before inundation of new areas created by a dam raise. A single staging area (landing) would serve each vegetation management area. Access for vegetation removal activities would most likely be limited to late summer and fall, when water levels were low and recreation use had decreased. Removal by helicopter is generally limited to spring and fall because of the limited availability of helicopters during the summer fire season. Vegetation removal would also be limited during bird nesting season, typically spring through summer. Reservoir area breeding surveys would be performed to determine the appropriate time frame for vegetation removal activities. Because of distance and/or safety constraints, helicopters would not be used in the following vegetation management areas: Bridge Bay, Lakeshore East, Pit Arm, and McCloud Arm. Slash burning could take place during the winter following vegetation treatment and would comply with all regulations set forth by the Shasta County Air Quality Management District. Methods for clearing the reservoir area are summarized below.



Complete Vegetation Removal Complete vegetation removal would clear all existing vegetation from the designated treatment area and would generally be applied to locations along and adjacent to developed recreation areas, including boat ramps, day use areas, campgrounds, marinas, and resorts. Exceptions would be made in areas with high shoreline erosion potential, or in habitat for special-status species.

Timber would be harvested and removed to landings by ground-skidding equipment if road access were present and slopes were less than 35 percent; otherwise, trees would be yarded by helicopter and residual vegetation and activity-created slash would be piled and burned by hand. Where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir walls. Tree stumps would be cut to within 24 inches of the ground surface and brush stumps would be cut flush to the ground. Stumps would be left in place to reduce shoreline erosion. Complete vegetation removal is intended to maximize shoreline access and minimize the risk to visitors from snags and water hazards.

Overstory Removal Overstory removal involves removing all trees from the treatment area that are greater than 10 inches in diameter at breast height, or 15 feet in height, generally in houseboat mooring areas or narrow arms of the reservoir where snags pose the greatest risk to boaters. Trees would be harvested and removed to landings by ground-skidding equipment if road access were present and slopes were less than 35 percent; otherwise, trees would be yarded by helicopter and activity-created slash would be piled and burned by hand. The remaining understory vegetation would be left in place. As for complete vegetation removal, where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir walls. Tree stumps would be cut to within 24 inches of the ground surface. Stumps would be left in place to reduce shoreline erosion. Overstory removal is intended to minimize the risk to visitors from snags and water hazards.

No Treatment Designated areas of the inundation zone would be left untreated with no vegetation removed. This prescription would generally be applied to stream inlets, the upper end of major drainages, the shoreline of wider arms of the reservoir, and special habitat areas. This treatment is intended to maximize the habitat benefits of inundated and residual vegetation.

Construction of Dam and Appurtenant Structures

This section summarizes major features associated with enlarging Shasta Dam and Reservoir and modifying its appurtenances for all action alternatives. Total surface area that would be required for work limits and permanent features, and an estimate of materials needed to modify Shasta Dam and its appurtenances, are included in the detailed description of each action alternative. For more detailed explanations of design considerations, please refer to the Engineering Summary Appendix.

Dam Crest Structure Removal Before any enlargement of Shasta Dam, existing structures on the dam crest would need to be removed. These structures include the gantry crane, existing spillway drum gates and frames, the spillway bridge, concrete in the spillway crest and abutments, upstream parapet walls, sidewalks, curbing, crane rails, and control equipment.

Modification of the main dam would require the demolition, removal, and transportation to waste of top-of-dam materials. This would include the demolition and removal of the upstream reinforced-concrete parapet wall and curb. Sawcuts would be used to aid in removing the upstream reinforced-concrete parapet wall and curb. In addition, sawcuts would be required along the upstream face and crest of the dam before the excavation of a 2-foot by 2-foot end area at the upstream face of the dam to embed a 12-inch polyvinyl chloride waterstop. The existing dam crest would be prepared by using a high-pressure water jet on the concrete surface. Existing roadway drains would be backfilled with cement grout.

Four-inch-diameter drain holes on 10-foot centers would be drilled from two different locations: from the existing dam crest to drain the surface contact, with each hole 2.5 feet long (248 holes), and from the existing dam crest for surface drainage at the downstream overhang, with one hole per block and each hole 6.5 feet long (50 holes). A 3-foot-diameter vertical shaft would be excavated through the concrete from the existing dam crest to the hoist gallery to install electrical conduit.

The existing spillway drum gates and piers would require removal according to a phased construction plan that would minimize impacts to reservoir operations during construction. Two drum gates and one pier would be removed to construct three new piers and install three new sloping fixed-wheel gates. This would be followed by removal of the remaining drum gate and pier to construct two new piers and install three new sloping fixed-wheel gates. This work would require two construction seasons to complete.

Removing the existing spillway bridge should be phased and/or scheduled to allow vehicular access across the dam for the longest time possible. The cantilever parapet wall sections at the dam crest would be removed by wire saw.

Control equipment for the TCD would be removed, stored, and reinstalled when the TCD structure is modified. The elevator on the dam would be removed, stored, and reinstalled for any of the dam raises. Storage would most likely be on site, within the parking lot of the left wing dam.

Main Gravity Dam Shasta Dam would be raised by placing mass concrete corresponding in width to the existing dam monolith blocks on the existing dam crest (concrete gravity section and spillway crest section). Structural concrete would be placed for the top of the dam, including for the roadway, the upstream and downstream parapets, and the walkway 1092.5 feet above mean sea level

(elevation 1,092.5). Reinforcing bars would be used around the utility gallery, and nominal temperature steel would be used for the exposed structural concrete surfaces. Two 6-inch-diameter steel top-of-dam drains would be furnished and installed in each block to drain to the upstream face. Surface area and features of the new dam crest would be similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide flood protection. The dam raise would include a new utility gallery and 5-inch-diameter formed drains on 10-foot centers.

Wing Dams Zoned embankment wing dams were originally constructed on both abutments of the main dam to protect the contact between the concrete and the excavated foundation surface. The left wing dam would be raised 20.5 feet to elevation 1,098.0 to maintain the same height above the top of joint-use storage, as for existing conditions. This would involve extending the existing reinforced-concrete core wall to the raised dam crest, and placing a thick layer of large rockfill downstream from the core wall. The upstream face would consist of a reinforced concrete or mechanically stabilized earth wall, and a concrete parapet wall to elevation 1,101.5. The road from the concrete dam crest would be ramped up through the left wing dam to the new embankment crest. Roadways and security features on the existing dam crest would be relocated to the new dam crest. The existing rotunda on the left abutment of the dam would be removed and reconstructed.

A building housing a visitor center and Reclamation offices, a parking lot, picnic areas, and vista points have been incorporated into the abutment design. The existing roadways, lawns, sidewalks, trees, and other features on the left wing dam crest would be restored to preraise configurations. Existing facilities would be removed from the site before construction, and replaced after the raise is completed.

The right wing dam would be raised to meet the dam crest. Concrete was selected for the right wing dam in lieu of embankment to facilitate construction. The new right wing dam crest would provide surface area and features similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide flood protection. The right wing dam would include a new utility gallery and a foundation drainage curtain. Right abutment access roads would be modified to match the new dam crest.

Spillway Structural concrete would be used to raise the existing spillway crest and to shape the raised spillway crest. The existing spillway bridge, two existing spillway piers, cantilever wall sections, and three existing drum gates and operating equipment would be removed. Five new spillway piers would be constructed at locations within the spillway, designed to avoid existing overflow block contraction joints, and a new concrete spillway crest would be constructed between them. The locations of the new piers would result in different widths of spillway gates. The three existing 110-foot by 28-foot drum gates would be replaced with six sloping, fixed-wheel gates (four 48-foot by 38-foot and two

54-foot by 38-foot gates). The total spillway crest length would decrease from 330 feet to 300 feet, as a result. A new bridge would be required over the spillway to allow for vehicular traffic and for a gantry crane to travel from one end of the dam to the other.

Temperature Control Device Modifications to the TCD would be needed for dam full pool elevation raises. Modifications would primarily include extending the main steel structure to the new full pool elevation; raising the TCD operating equipment, including gate hoists, electrical equipment, miscellaneous metalwork, and hoist platform above the new top of joint-use elevation; and lengthening/replacing shutter operating cables.

Shasta Powerplant Penstock Intake and Penstock Modifications The centerline of the existing penstock intakes would remain at the current level, but the gate hoists would require relocation with a higher dam crest. Additional penstock foundations providing seismic restraint would be constructed on the exposed portion of the penstocks downstream from the dam, regardless of the size of the dam raise, to address identified existing seismic deficiencies.

Pit 7 Dam Powerhouse The only expected modifications to the Pit 7 Powerhouse associated with the proposed action include installation of a tailwater depression system. During high flows, a tailwater depression system would introduce compressed air into the turbine runner pit to depress the tailwater to a level that does not interfere with turbine operation, thereby allowing continued turbine operation.

The tailwater depression system would include air compressors, air discharge piping with control valves, water-level sensors, power supply, and electrical controls. Air compressors would be of the high-volume, low-pressure type, referred to as “blowers.” Blowers would be driven by electric motors supplied with available power from the Pit 7 Powerhouse.

Reservoir Area Dikes and Railroad Embankments

The proposed dikes would be constructed using common earthmoving equipment and methods. Additional excavation to provide working surfaces and keys for the embankment fill would be required along the slope of the upstream foundation for some of the proposed dikes. Ground treatment and/or over-excavation may be necessary in some areas to remove and/or treat pervious material. It is expected that approximately 1 foot of organic-rich soil and vegetation would be excavated from the foundation of the proposed dikes, and a shear key on the upstream sides of the dikes. Riprap would be placed on the upstream face of each dike to the crest of the dike to protect against wave run-up and erosion. The volume of riprap required for each dike is summarized below in the detailed description of each action alternative. Reservoir dikes are further described in the Engineering Summary Appendix.

Relocations

As a result of the proposed Shasta Dam raise, the following major features would be inundated by the increase in full pool elevation. Existing infrastructure affected by enlarging Shasta Dam and Reservoir would need to be removed and/or relocated.

Roadways Criteria were established for four typical road replacement scenarios. Road design criteria and construction characteristics are discussed in detail in the Engineering Summary Appendix.

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; performing construction-related traffic control; and establishing and maintaining a Stormwater Pollution Prevention Plan (SWPPP). Noisy equipment, such as pile drivers, are anticipated for road construction work. Typical noise would result from trucks and diesel-powered equipment.

Replacement roadways would be constructed by excavating the existing up-grade slope to provide fill material for the embankment fill portion of road construction; bench-excavating into the up-grade slope above the existing roadway to establish the new road finished grade; building the new road on an engineered fill embankment from imported borrow material; or building the new road directly above the existing road on an engineered fill embankment from imported borrow material. A road alignment may use either a single method of construction for the entire alignment, or it may use all four methods at different locations along an alignment. To limit impacts to existing roadways, road closures would be avoided whenever possible.

Estimated work limits for road segment relocation are described in the Engineering Summary Appendix. Estimated work limits depend on the surrounding terrain, and vary from a minimum of 5 feet to 30 feet wide, measured from the extent of earthwork. Where the road would be constructed as an embankment fill against an existing steep hillside, a 5-foot-wide minimum work area would be used. Where the terrain beyond the limit of earthwork was flat enough to be used as work areas for construction equipment, the work limits would range from 15 feet to 30 feet wide. Features associated with proposed roadway relocations for all action alternatives are summarized below in the detailed description of each action alternative.

Vehicle Bridges As a result of raising Shasta Dam for any of the action alternatives, the following local road vehicle bridges would be replaced:

- Charlie Creek Bridge
- Doney Creek Bridge

- McCloud River Bridge
- Didallas Creek Bridge

Criteria and assumptions considered in determining structure type and length for the replacement structures are included in the Engineering Summary Appendix. Based on the design criteria and assumptions, and considering preliminary horizontal alignments and profile grades developed for the relocated roadways, Table 2-7 summarizes proposed bridge characteristics for the four road bridges requiring replacement under all action alternatives.

Table 2-7. Features of Proposed Bridge Relocations Common to All Action Alternatives

Bridge Feature	Charlie Creek Bridge	Doney Creek Bridge	McCloud River Bridge	Didallas Creek Bridge
Bridge Length (lf)	782	760	490	115
Number of Abutments	2	2	2	2
Number of Piers	4	4	4	0
Pier Diameter (lf)	14	14	6	N/A
Volume of Backfill (cy)	480	400	530	180
Volume of Concrete (cy)	3,530	3,320	2,320	760
Quantity of Steel (tons)	575	516	380	104
Number of Class 140 Piles	24	24	24	24
Number of 24-inch Cast-In-Steel-Shell Piles	72	72	32	N/A
Volume of Excavated Material (cy)	1,200	550	820	440
Quantity of Demolished Material (cy)	3,500	3,300	2,300	800

Key:

cy = cubic yards

lf = linear feet

N/A = not applicable

sf = square feet

SLWRI = Shasta Lake Water Resources Investigation

Construction would take place during the low-water season, and is expected to last between 6 and 8 months. The waterway would remain clear for navigation during construction. Bridge construction would begin with piers and abutments. To allow underwater construction of pier foundations, steel pile shells would be driven into the lake bed to create a temporary cofferdam. It may be necessary to dewater the shells during drilling if water seeps in. A hole would then be drilled to the specified foundation depth. Reinforcing steel would be installed within the shells before concrete was poured. After completion of the piers and abutments, construction of the superstructure and bridge deck would begin via the balanced cantilever method. This process entails forming and constructing the horizontal structure outward from the piers in each direction, in equal (balanced) proportions, until the superstructure/deck segments meet at midspan.

Traffic would continue on the existing bridges during construction. It is likely that barges would be used extensively for bridge foundation construction, bridge assembly, transport of materials, workers, and equipment, and demolition of the existing bridges. Concrete would be poured from barges. A

staging area would be required on the lakeshore, from which barges could be loaded and unloaded.

Although Fender's Ferry Bridge would not need to be replaced as a result of the Shasta Dam raises, modifications to the bridge would be necessary. The Fender's Ferry Bridge is a three-span structure with a steel plate girder superstructure supported on riveted steel tower bents and reinforced concrete piers with spread footings. As a result of differences in east and west riverbank topography, the western pier steel tower is supported at a much lower elevation than the eastern pier tower. Thus, at the proposed full pool elevations, the eastern pier steel tower would be inundated.

The existing reinforced concrete pier and footing would be enlarged and extended, and the existing steel tower modified to prevent inundation as a result of the higher full pool levels associated with the dam raise scenarios under consideration. Proposed modifications include the following:

- Enlarging the existing reinforced concrete footing.
- Enlarging and extending the existing reinforced concrete columns and pier wall to elevation 1096.16.
- Removing approximately 24 feet of the lower portion of the eastern pier steel tower (based on location of existing cross bracing).
- Reusing the existing steel bearing assemblies.

Quantities for the major items of work are estimated in the Engineering Summary Appendix.

Construction activities would likely be completed from the existing embankment without constructing cofferdams around the pier because average water surface elevations are below the existing eastern pier bottom-of-footing elevation for all months, with the exception of April and May. Construction of temporary bents to support the superstructure would be necessary to facilitate construction of the pier modifications. During construction activities, temporary traffic controls may be needed to facilitate delivery of materials and construction of temporary support bents.

Railroad Bridges

Pit River Bridge Pier Modification The new full pool elevations would inundate the existing bridge bearings and low-chord steel truss members. To prevent the existing steel bearings and lower portions of the steel truss members from being submerged, a watertight concrete tub structure would be required. The reinforced concrete structure would be attached to the top of two existing concrete piers. The structure footprint would be rectangular and approximately 151 feet long by 52.5 feet wide.

Because the existing bridge superstructure and top-of-pier are exposed to the elements, a structure cover would not be required; however, two submersible sump pumps would be installed to keep the water level in the new concrete protective structure from rising near the bearings. Each pump would discharge into 2-inch-diameter copper tubing, and the two lines would tee into a 2.5-inch-diameter line that would follow the slope upward to the discharge point. Check valves and ball valves would prevent pumped water from draining out of the line back into the sump. Protective grates would prevent large objects from entering the sump area.

Union Pacific Railroad Bridges The existing Sacramento River Second Crossing and Doney Creek railroad bridge superstructures consist of deck truss bridges with a single track. The piers and abutments were designed to accommodate a future parallel single-track superstructure. Portions of both bridges would be submerged for any reservoir raise and would need to be replaced with new, higher superstructures. Structural analyses of the existing bridge piers under design earthquake loads indicated that new bridge piers would be required. Minimal changes would be required for the railroad vertical alignment. The feasibility designs would permit uninterrupted rail service during construction.

The proposed new bridge superstructure would be a composite superstructure consisting of steel plate girders and a reinforced concrete deck. In general, the bridge superstructures would be designed to be continuous over the piers. However, with a requirement for 16 feet of vertical clearance between the two westernmost piers (underneath Span 2) for the Sacramento River Second Crossing railroad bridge (with a minimum width of 30 feet), to allow for the passage of houseboats, Span 2 is a simply supported span. No minimum clearance for houseboat traffic would be required for the Doney Creek railroad bridge; large-diameter concrete columns with drilled shafts would support the superstructure and be founded on bedrock. The Sacramento River Second Crossing railroad bridge would require nine spans, with a total length of 982 feet between concrete abutments. The Doney Creek railroad bridge would require five spans, with a total length of 537.5 feet between concrete abutments. The proposed relocation of the railroad bridges would require the railroad tracks to be realigned between the two bridges. This realignment would parallel the existing tracks with a 25-foot offset to the east.

Recreation Facilities Any raise of Shasta Dam would have some effect on the many recreation features found along the reservoir shoreline. These features include marinas/boat ramps, resorts, campgrounds/day use areas, cabins, trails, and USFS facilities. Areas for potential recreation mitigation (referred to as windows) and corresponding relocation plans for each window have been developed. Figure 2-4 details the location of these windows and existing recreation sites with proposed modification, expansion, or relocation. After authorization of the project, further detailed designs would need to be developed.

Shasta Lake Water Resources Investigation Environmental Impact Statement

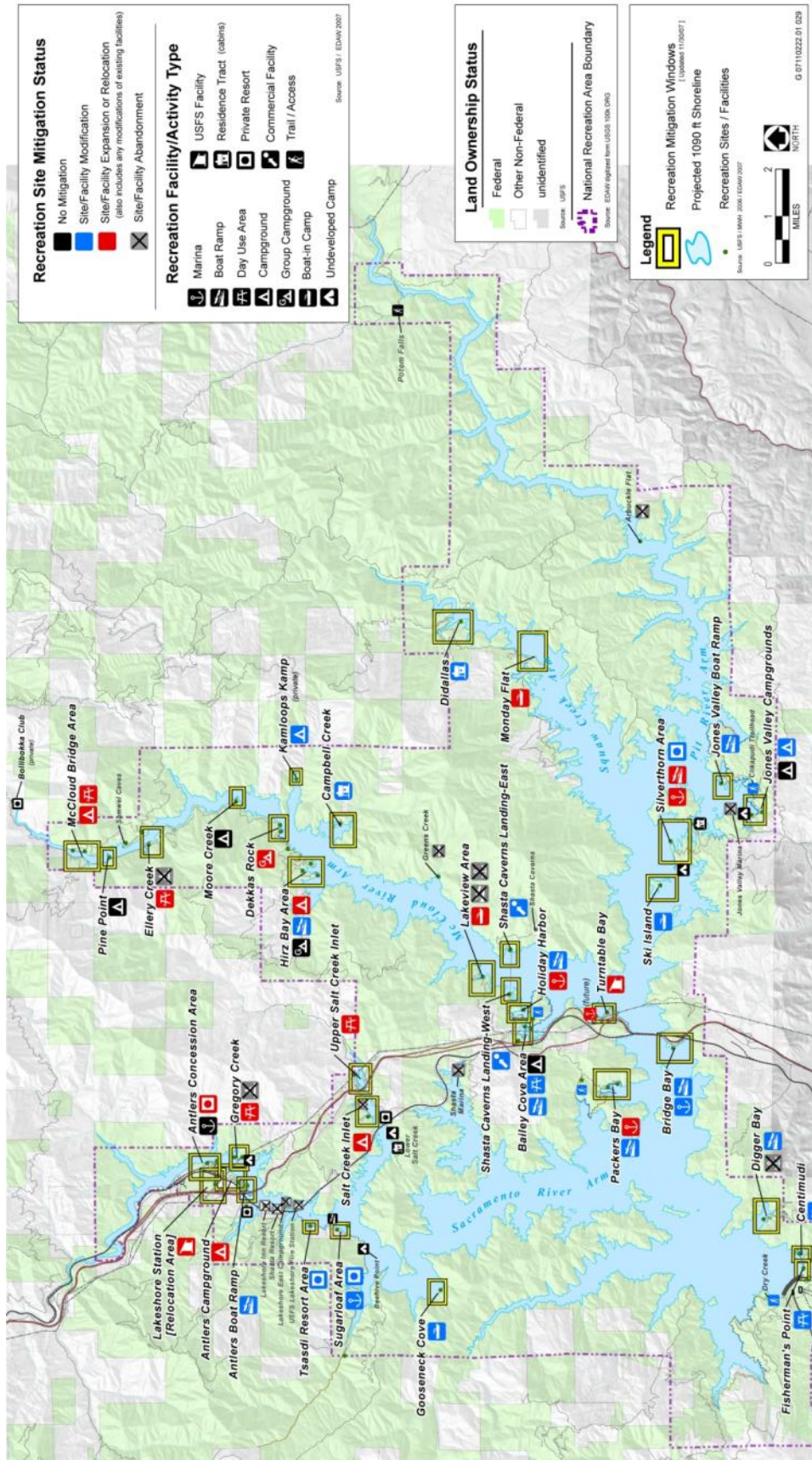


Figure 2-4. Recreation Mitigation Study Windows

The primary goal of the relocation plans is to verify that with any dam raise, the existing recreation capacity could be maintained. Reclamation and USFS would continue to work together to revise a recreation plan that is suitable for the NRA.

Inundated recreation facilities and associated utilities would be relocated before demolition, with the exception of facilities identified for abandonment. Action alternatives would, at minimum, maintain the existing recreation capacity at Shasta Lake. Recreation facilities proposed for relocation are included below in the detailed description of each action alternative. Construction-specific information regarding relocating and demolishing recreation facilities is under development and will be completed after project authorization.

Marina/Boat Ramp Modifications Several marinas around Shasta Lake would be affected by raising Shasta Dam. Typically, marinas consist of a parking area, a boat ramp, various structures (retail, restrooms, maintenance facilities, storage, administration, etc.), and utilities (power, water, and septic). Most of the effects of the dam raise would be due to the inundation of boat ramps, parking lots, structures, and utilities. Boat ramps would be modified in place, on fill, where possible. Parking areas would be replaced on fill, or relocated above the new reservoir elevation. Existing structures that would be inundated would be demolished, and either replaced above the reservoir elevation (upslope or on placed fill), or moved to a floating structure on the water to provide better access for recreational users. Any access roads would be relocated above the new full pool for continued access around the marinas. Existing septic systems that would be inundated would be demolished and removed from the area or relocated. New facilities could also be connected to new localized wastewater treatment facilities. Power lines would be installed to accommodate new structures.

Marinas and boat ramps that could not be modified in place would be relocated to adjacent areas that can provide the necessary grade and access for ramps. To maintain current recreation capacity, 10.7 acres of expanded, or new, boat ramp and/or marina land use would be needed. The following potential areas could be used to meet this need:

- Antlers Boat Ramp and Adjacent Marina Area
- Packers Bay Marina
- Silverthorn Marina Area
- Holiday Harbor

Resort Modifications Raising Shasta Dam would affect approximately six resorts around the reservoir to some degree. Inundated structures and structures within 3 feet of the new full pool would be demolished. Septic systems would also be demolished, and remaining structures would either connect to new

localized wastewater treatment facilities or relocated to other septic systems. Fourteen acres of land would be needed to maintain the current resort capacity.

Campground/Day Use Area Modifications Many undeveloped areas have been identified as potential campgrounds to replace capacity lost because of inundation. While some inundated campgrounds would be relocated on fill at their existing location, others would be moved around the reservoir to new locations identified as potential campground sites. Thirty acres of expanded, or new, campgrounds would be needed to maintain the current recreation capacity. The following areas could be used to meet this need:

- Antlers Campground
- Oak Grove Campground
- Hirz Bay Campground
- McCloud Bridge Area

Six acres of expanded, or new, boat-in campgrounds would be needed to maintain the current recreation capacity. The following areas could be used to meet this need:

- Lakeview Marina Area
- Monday Flat Boat-In Camp

Six acres of expanded, or new, day-use campgrounds would be needed to maintain the current recreation capacity. The following areas could be used to meet this need:

- Ellery Creek Campground
- Gregory Creek Campground
- McCloud Bridge Area
- Upper Salt Creek

USFS Facilities Modifications Recreation within the NRA is managed by USFS, which has several facilities located throughout the reservoir area. USFS facilities consist of various storage and maintenance buildings and equipment, fire protection equipment, customer service facilities, office space, and employee living facilities. Two USFS facilities would be inundated, and require relocation or replacement. The station located in the Lakeshore area would be inundated by a Shasta Dam raise, and would be relocated to an area above the new full pool. The new facility would contain all of the features that exist at the current facility. The inundated facility would be demolished, and hauled to waste. Turntable Bay, another USFS facility, would be inundated by a Shasta Dam raise. Additional space at Turntable Bay would allow the facility to be relocated on fill in its current location.

Utilities and Miscellaneous Minor Infrastructure Gas/petroleum facilities, potable water facilities, power and telecommunications infrastructure, and wastewater facilities would be relocated. New facilities would be designed and constructed in accordance with applicable Federal, State, and local codes and requirements. Relocated facilities would be of the same types, sizes, and materials as existing facilities. Demolished facilities would not be reused to construct relocated facilities. Demolished and relocated utilities are summarized as part of the detailed description of each action alternative. An expanded discussion of the approach and methodology for demolition, design, and relocation criteria for each category of utilities is included in the Engineering Summary Appendix.

Construction Staging

Reclamation would establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with the resource agencies. Staging areas would likely be located within disturbed areas or at existing facilities that are expected to be inundated, such as campgrounds, recreation parking facilities, the top of Shasta Dam, and the parking area along the left wing dam, where feasible.

Staging areas would have a stabilized entrance and exit and would be located at least 100 feet from bodies of water, if possible. If an off-road site is chosen, qualified biological and cultural resources personnel would survey the selected site to verify that no sensitive resources would be disturbed by staging activities. If sensitive resources were found, an appropriate spatial and temporal buffer zone would be staked and flagged to avoid impacts. Where possible, no equipment refueling or fuel storage would take place within 100 feet of a body of water.

Construction Schedule, Equipment, and Workforce

Total construction duration is estimated at 3 to 4 years. An overlap is expected in the timing of construction of some of the construction components. Construction would be phased, when feasible, to avoid negative environmental impacts.

Construction would typically occur during daylight hours, Monday through Friday. However, construction contractors may extend these hours and schedule construction work on weekends, if necessary, to complete aspects of the work within a given time frame. Construction would require typical heavy construction equipment including excavators, backhoes, bulldozers, scrapers, graders, water trucks, front-end loaders, dump trucks, drill rigs, pump trucks, truck-mounted cranes, pickup trucks, barges, helicopters, and miscellaneous equipment.

About 58 highway truck trips would be needed per day to bring construction material to the site. In addition, about 23 highway truckloads per day could be

needed to carry construction debris and waste material to a suitable landfill. The construction labor force is estimated to average about 350 people over the total construction period.

Borrow Sources

Multiple borrow sources are available to meet project needs for concrete, sand and gravel, core and homogenous fill, shell fill, riprap, and filter and drain materials for reservoir area embankments. Potential borrow sources were examined at a preliminary level and would need further sampling and testing to determine suitability and refine quantity estimates. Potential borrow sources include areas of the dike construction sites, areas located below the reservoir's inundation zone, and commercial sources. Commercial sources are located within approximately 2 to 30 miles of the Bridge Bay site, and within approximately 15 to 43 miles of the Lakeshore sites. Potential borrow sources are identified in Figure 2-5. Available fill material from potential borrow sources are described in the Engineering Summary Appendix.

2.4.3 Environmental Commitments Common to All Action Alternatives

As part of project planning and environmental assessment, Reclamation and/or its contractors would incorporate certain environmental commitments and best management practices (BMP) into the SLWRI action alternatives to avoid or minimize potential impacts. Reclamation will also coordinate planning, engineering, design and construction, operation, and maintenance phases of the project with applicable resource agencies.

The following environmental commitments would be incorporated into any action alternative for any project-related construction activities.

Develop and Implement Construction Management Plan

Reclamation would develop and implement a construction management plan to avoid or minimize potential impacts to public health and safety during project construction, to the extent feasible. The construction management plan would inform contractors and subcontractors of work hours, modes and locations of transportation and parking for construction workers; location of overhead and underground utilities; worker health and safety requirements; truck routes; stockpiling and staging procedures; public access routes; terms and conditions of all project permits and approvals; and emergency response services contact information.

The plan would also include construction notification procedures for the police, public works, and fire department in the cities and counties where construction occurs. Notices would also be distributed to neighboring property owners.

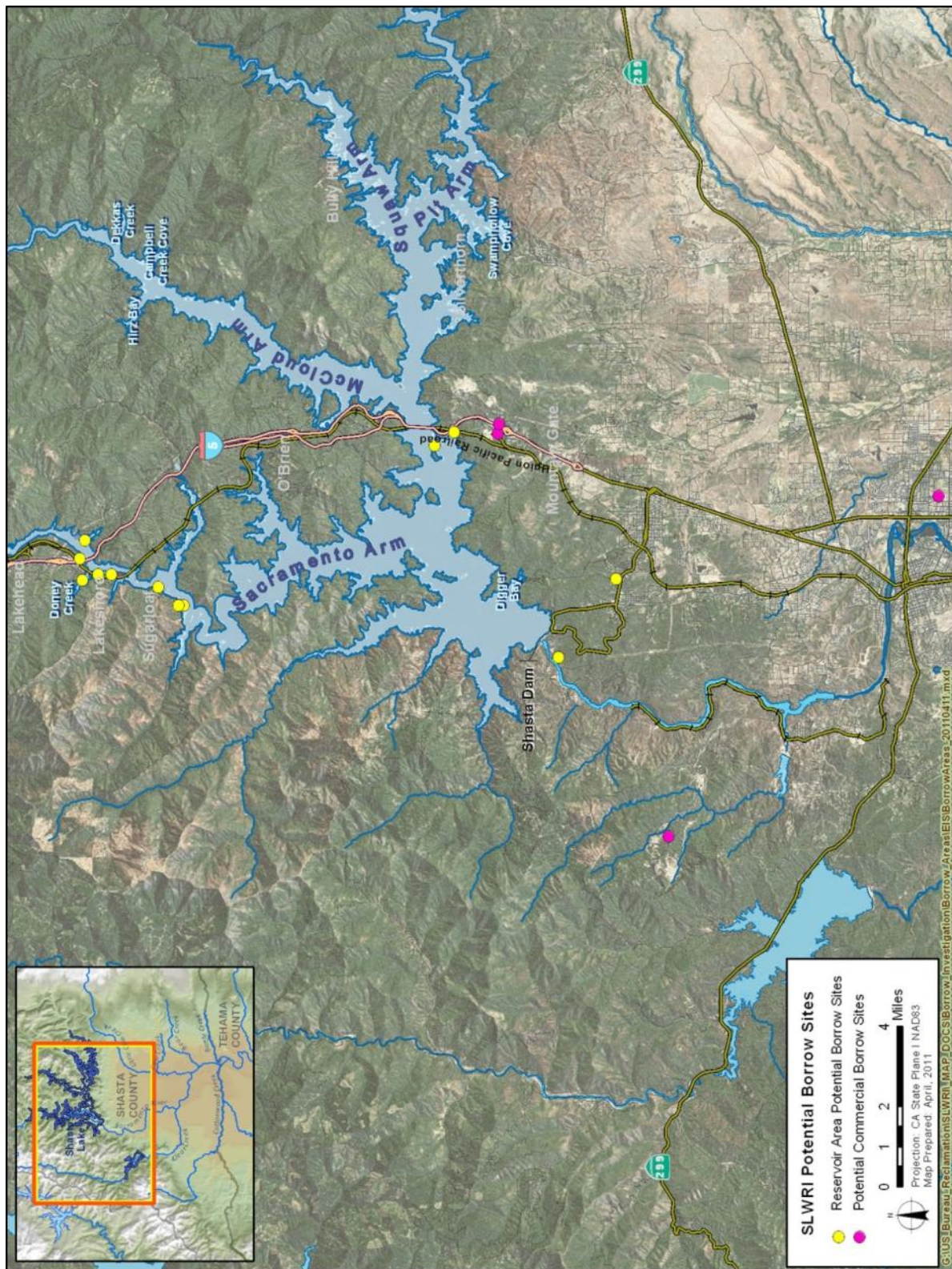


Figure 2-5. Potential Borrow Sources

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The plan would also include construction notification procedures for the police, public works, and fire department in the cities and counties where construction occurs. Notices would also be distributed to neighboring property owners.

Comply with Permit Terms and Conditions

Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor's subcontractors and suppliers to comply with all of the terms and conditions of all project permits, approvals, and conditions attached thereto. Compliance with applicable laws, policies, and plans for this project is discussed in Section 26.6 of this PDEIS.

Develop and Implement Erosion and Sediment Control Plan

Reclamation would prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects, and to stabilize soils and vegetation in areas affected by construction activities. The plan would include all of the necessary local jurisdiction requirements regarding erosion control, and would implement BMPs for erosion and sediment control, as required. Types of BMPs may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, and use of silt fencing, sediment basins, fiber rolls, and sandbag barriers.

Develop and Implement Stormwater Pollution Prevention Plan

This project is subject to construction-related stormwater permit requirements of the Federal Clean Water Act (CWA) National Pollutant Discharge

Elimination System program. Reclamation would obtain any required permits through the Central Valley Regional Water Quality Control Board before any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation and/or its contractors would prepare and implement a SWPPP before construction that identifies BMPs to prevent or minimize the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters. The SWPPP would include development of site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and measures to be implemented before each storm event. The SWPPP would contain a site map that shows the construction site perimeter, existing and proposed buildings, lots, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project. Additionally, the SWPPP must contain a visual monitoring program, a chemical monitoring program for “non-visible” pollutants to be implemented if a BMP fails, and a sediment monitoring plan if the site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

Develop and Implement Feasible Spill Prevention and Hazardous Materials Management

As part of the SWPPP, Reclamation and/or its contractors would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible measures would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be readily moved out of the water body would not be fueled in the water body or immediate floodplain. As for stationary equipment, for all fueling done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented. These may include, but would not be limited to, the following:

- Storage of hazardous materials in double-containment and, if possible, under a roof or other enclosure.
- Disposal of all hazardous and nonhazardous products in a proper manner.
- Monitoring of on-site vehicles for fluid leaks and regular maintenance to reduce the chance of leakage.
- Containment (using a prefabricated temporary containment mat, a temporary earthen berm, or other measure can provide containment) of bulk storage tanks.

Fisheries Conservation

The measures discussed below would be implemented to minimize potential adverse effects to fish species.

Implement In-Water Construction Work Windows Reclamation would identify and implement feasible in-water construction work windows in consultation with NMFS, USFWS, and California Department of Fish and Game (DFG). In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance (e.g., July through September).

Monitor Construction Activities A qualified biologist would monitor potential impacts to important fishery resources throughout all phases of project construction. Monitoring may not be necessary during the entire duration of the project if, based on the monitor's professional judgment (and with concurrence from Reclamation), a designated on-site contractor would suffice to monitor such activities and would agree to notify a biologist if aquatic organisms are in danger of harm. However, the qualified biologist must be available by phone and Internet and be able to respond promptly to any problems that arise.

Perform Fish Rescue/Salvage If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective measures were completed or it was determined that the fish would not be harmed.

A qualified biologist would identify any fish species that may be impacted by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal Endangered Species Act section 4(d) scientific collection take permit, or a Memorandum of Understanding). If fish are identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to

allow fish to leave the project area before resuming work. If fish are unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

Reporting A qualified biologist would prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts. Monitoring logs would be maintained and provided, with monitoring reports. The reports would contain, but not be limited to, the following: summary of activities; methodology for fish capture and release; table with dates, numbers, and species captured and released; photographs of the enclosure structure and project site conditions affecting fish; and recommendations for limiting impacts during subsequent construction phases, if appropriate.

Water Quality Protection

The measures discussed below would be implemented to minimize potential adverse effects to water quality.

Implement In-Water Construction Work Windows All construction activities along the Sacramento River would be conducted during months when instream flows are managed outside the flood season (e.g., June 15 to September 15).

Comply with All Permits and Regulations Project activities would be conducted to comply with all additional requirements specified in permits relating to water quality protection. Relevant permits anticipated to be obtained for the proposed action include a California Fish and Game Code 1602 Lake and Streambed Alteration Agreement, Regional Water Quality Control Board Section 401 certification or waiver, and CWA Section 404 compliance through the U.S. Army Corps of Engineers (USACE).

Implement Water Quality Best Management Practices BMPs that would be implemented to avoid and/or minimize potential impacts associated with dam construction and the 10-year-long spawning gravel augmentation program are described below.

Handle Spawning Gravel to Minimize Potential Water Quality Impacts Gravel would be sorted and transported in a manner that minimizes potential water quality impacts (e.g., management of fine sediments, etc.). Gravel would be washed at least once and have a cleanliness value of 85 or higher based on CalTrans Test No. 227. Gravel would also be completely free of oils, clay, debris, and organic material.

Minimize Potential Impacts Associated with Equipment Contaminants For in-river work, all equipment would be steam-cleaned every day to remove hazardous materials before the equipment entered the water.

Minimize Potential Impacts Associated with Access and Staging Existing access roads would be used to the extent possible. Equipment staging areas would be located outside of the Sacramento River ordinary high water mark or the Shasta Dam full pool inundation area, and away from sensitive resources.

Remove Temporary Fills as Appropriate Temporary fill for access, side channel diversions, and/or side channel cofferdams, would be completely removed after completion of construction.

Remove Equipment from River Overnight and During High Flows Construction contractors would remove all equipment from the river on a daily basis at the end of the workday. Construction contractors would also monitor Reclamation's Central Valley Operations Office Web site daily for forecasted flows posted there to determine and anticipate any potential changes in releases. If flows are anticipated to inundate a work area that would normally be dry, the contractor would immediately remove all equipment from the work area.

Revegetation Plan

Reclamation, in conjunction with cooperating agencies and private landowners, would prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., erosion and sediment control plan). This plan would apply to any area included as part of an action alternative, such as inundation, relocation, or mitigation activities. Overall objectives of the plan would be to reestablish native vegetation to control erosion; provide effective ground cover; minimize opportunities for nonnative plant species to establish or expand; and provide habitat diversity over time. Reclamation would work closely with cooperating agencies, private landowners, and revegetation specialists to develop the site-specific planting patterns and species assemblages necessary for a revegetation effort of this magnitude.

Invasive Species Management

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Shasta Lake, the shoreline of Shasta Lake, the Sacramento River, and any riverbanks, floodplains, or riparian areas. Plan activities may include, but would not be limited to, the following:

- Preinspection and cleaning of all construction vehicles, watercraft, and equipment before being shipped to project areas, and postinspections.

- Reinspection of all construction vehicles, watercraft, and equipment on arrival at project areas
- Inspection and cleaning of all personnel before work in project areas

All inspections would be conducted by trained personnel and would include both visual and hands-on inspection methods of all vehicle and equipment surfaces, up to and including internal surfaces that have contacted raw water.

Approved cleaning methods would include a combination of the following:

- Precleaning: draining, brushing, vacuuming, high-pressure water treatment, thermal treatment
- Cleaning: freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

On-site cleanings would require capture, treatment, and/or disposal of any and all water needed to conduct cleaning activities.

Construction Material Disposal

Reclamation's contractors would take measures to recycle or reuse demolished materials, such as steel or copper wire, where practical.

Asphalt Removal

Per California Fish and Game Code 5650 Section (a), all asphaltic roadways and parking lots inundated by the proposed action would be demolished and removed according to Shasta County standards. Asphalt would be disposed of at an approved and permitted waste facility. Dirt roads inundated by the proposed action would remain in place.

2.4.5 Comprehensive Plan 1 (CP1) – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 consists of enlarging Shasta Dam by raising the crest 6.5 feet and enlarging the reservoir by 256,000 acre-feet.

Major Components of CP1

CP1 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 6.5 feet.
- Implementing the set of eight common management measures described above.

By raising Shasta Dam 6.5 feet from a crest at elevation 1,077.5 to elevation 1,084.0, CP1 would increase the height of the reservoir full pool by 8.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications, including replacing the three

drum gates with six sloping, fixed-wheel gates. This increase in full pool height would add approximately 256,000 acre-feet of additional storage to the overall reservoir capacity. Accordingly, the overall full pool storage would increase from 4.55 MAF to 4.81 MAF. Table 2-8 summarizes major physical features associated with CP1.

Under CP1, operations for water supply, hydropower, and environmental requirements would be similar to existing operations, with the additional storage retained for water supply reliability and as an expanded cold-water pool for fisheries benefits. As mentioned, this alternative (and all comprehensive plans) includes extending the existing TCD for efficient use of the expanded cold-water pool.

CP1 would also include the potential to revise the operational rules for flood control for Shasta Dam and Reservoir, which could reduce the potential for flood damage, and benefit recreation. Reservoir reoperation would likely include increasing the bottom of the flood control pool elevation based on increased dam height and reservoir capacity. Because of reservoir geometry, this would decrease the depth of the flood control pool, allowing higher winter and spring water levels. Increased reservoir capacity could have further flood damage reduction benefits in years when water levels are below the new flood control pool elevation.

There is also limited potential for changes in flood control rules to allow more operational flexibility in reservoir drawdown requirements in response to storms, resulting in a net increase in the rate of spring reservoir filling during some years. Higher spring water levels and associated increases in reservoir surface area would benefit recreation.

Table 2-8. Physical Features of Action Alternatives

Main Features	Action Alternatives				
	CP1	CP2	CP3	CP4	CP5
Dam and Appurtenant Structures					
Shasta Dam					
<i>Crest Raise (feet)</i>	6.5	12.5	18.5	18.5	18.5
<i>Full Pool Height Increase (feet)</i>	8.5	14.5	20.5	20.5	20.5
<i>Elevation of Full Pool (feet)</i>	1,075.5	1,081.5	1,087.5	1,087.5	1,087.5
<i>Capacity Increase (acre-feet)</i>	256,000	443,000	634,000	634,000	634,000
<i>Wing Dams</i>	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.
<i>Spillway</i>	Raise crest and extend piers. Replace 3 drum gates with 6 sloping wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping wheel gates.
<i>Temperature Control Device</i>	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.
Shasta Powerplant	Raise hoists.	Raise hoists.	Raise hoists.	Raise hoists.	Raise hoists.
Pit 7 Dam	Install a tailwater depression system.	Install a tailwater depression system.	Install a tailwater depression system.	Install a tailwater depression system.	Install a tailwater depression system.
Reservoir Area Dikes and Railroad Embankments	Construct 5 new dikes.	Construct 6 new dikes.	Construct 7 new dikes.	Construct 7 new dikes.	Construct 7 new dikes.
Relocations					
Roadways	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.
<i>Length of Relocated Roadway (linear feet)</i>	17,409	29,054	33,788	33,788	33,788
<i>Number of Road Segments Affected</i>	10	21	30	30	30

Table 2-8. Physical Features of Comprehensive Plans (contd.)

Main Features	Project Alternatives				
	CP1	CP2	CP3	CP4	CP5
Vehicle Bridges	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.
Railroad Bridges	Modify 3 bridges.	Modify 3 bridges.	Modify 3 bridges.	Modify 3 bridges.	Modify 3 bridges.
Recreation Facilities	Modify or replace 9 marinas, 6 boat ramps, 6 resorts, 202 campgrounds/day-use areas/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 boat ramps, 6 resorts, 261 campgrounds/day-use areas/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and 18 miles of new hiking trails.
Utilities	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.
Ecosystem Enhancements	None	None	None	Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore 0.8 miles of riparian, floodplain, and side channel habitat along the upper Sacramento River.	Construct shoreline fish habitat around Shasta Lake. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore 0.8 miles of riparian, floodplain, and side channel habitat along the upper Sacramento River. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage.

Key:
 CP = comprehensive plan
 GWh = gigawatt-hour
 RV = recreational vehicle
 TAF = thousand acre-feet
 USFS = U.S. Department of Agriculture, Forest Service

Potential Benefits of CP1

Major potential benefits of CP1, related to contributions to the SLWRI objectives and broad public services, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. CP1 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critically dry water years. This would be accomplished by raising Shasta Dam 6.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBDD. It is estimated that under CP1, improved water temperature conditions could result in an average annual increase in the salmon population of about 366,000 out-migrating juvenile Chinook salmon.

Increase Water Supply Reliability CP1 would increase water supply reliability by increasing firm water supplies for irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the Central Valley Project Improvement Act (CVPIA), which would help reduce estimated future water shortages by increasing firm yield for agricultural and M&I deliveries by at least 76,400 acre-feet per year and average annual yield by about 46,400 acre-feet per year. For this PDEIS, firm yield is considered equivalent to the estimated increase in the reliability of supplies during dry and critically dry periods. The majority of increased firm yield (66,800 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP1, approximately \$2.3 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in an increase in power generation of about 42 gigawatt-hours (GWh) per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities.

Maintain and Increase Recreation Opportunities CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake. Although CP1 does not include specific features to further benefit recreation resources, a small benefit would likely occur to the water-oriented recreation experience at Shasta Lake due to the increase in lake surface area and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,110 acres (4 percent), from 29,600 acres to about 30,700 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by raising the bottom of the flood control pool elevation and allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Objectives CP1 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP1, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Furthermore, CP1 could potentially benefit ecosystem restoration through improved Delta water quality conditions by increasing Delta outflow during drought years and reducing salinity during critical periods. CP1 may also contribute to improving Delta water quality through increased Delta emergency response capabilities. When Delta emergencies occur, additional water in Shasta Reservoir could improve operational flexibility for increasing releases to supplement existing water sources to reestablish Delta water quality. In addition to Delta emergency response, increased storage in Shasta Reservoir could increase emergency response capability for CVP/SWP water supply deliveries.

Construction for CP1

Construction activities for CP1 are described in Section 2.4.2, “Construction Activities Common to All Action Alternatives.” Information specific to CP1 construction activities is summarized in Tables 2-9 through 2-15.

Table 2-9. Reservoir Clearing Treatment Applied – CP1

Landing	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)
Antlers	8	48,600	5	33,400
Bailey Cove	17	148,400	7	40,600
Beehive Point	3	5,400	24	102,300
Bridge Bay	9	51,800	0	0
Digger Bay	8	27,700	31	92,600
Hirz Bay	22	211,200	22	169,500
Jones Valley	17	81,700	51	328,000
Lakeshore East	17	58,800	2	12,500
Lower Salt Creek	14	96,300	15	62,700
McCloud Arm	4	14,900	0	0
Packers Bay	7	29,200	22	78,800
Pit Arm	2	22,400	0	0
Shasta Marina	1	17,900	13	89,400
Silverthorn	17	117,900	18	115,100
Turntable	5	33,100	8	88,700
Total	150	965,300	220	1,213,600

Key:

CP = comprehensive plan

Table 2-10. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances – CP1

Physical Features	Quantities
Quantity of Concrete (cubic yards)	56,972
Quantity of Cement (tons)	128,589
Quantity of Metalwork (pounds)	19,712,823
Volume of Imported Fill Material (cubic yards)	61,220
Volume of Excavation to Waste Material (cubic yards)	1,610
Quantity of Demolished Material (cubic yards)	31,647
Area of Permanent Structures (square feet)	412,570
Area of Work Limits (square feet)	460,920

Key:

CP = comprehensive plan

Table 2-11. Physical Features for Proposed Dikes – CP1

Dike Features	Quantities
Lakeshore Dikes	
Doney Creek Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	-
Volume of Riprap (cubic yards)	-
Volume of Excavated Material (cubic yards)	-
Site Clearing and Grubbing Below Dike (acres)	-
Antlers Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	-
Volume of Riprap (cubic yards)	-
Volume of Excavated Material (cubic yards)	-
Site Clearing and Grubbing Below Dike (acres)	-
North Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	17,142
Volume of Riprap (cubic yards)	410
Volume of Excavated Material (cubic yards)	1,503
Site Clearing and Grubbing Below Dike (acres)	1.15
Middle Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	13,350
Volume of Riprap (cubic yards)	320
Volume of Excavated Material (cubic yards)	3,985
Site Clearing and Grubbing Below Dike (acres)	2.88
South Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	101,942
Volume of Riprap (cubic yards)	2,460
Volume of Excavated Material (cubic yards)	8,503
Site Clearing and Grubbing Below Dike (acres)	6.22
Bridge Bay Dikes	
West Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	3,015
Volume of Riprap (cubic yards)	230
Volume of Excavated Material (cubic yards)	2,122
Site Clearing and Grubbing Below Dike (acres)	0.79
East Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	956
Volume of Riprap (cubic yards)	40
Volume of Excavated Material (cubic yards)	927
Site Clearing and Grubbing Below Dike (acres)	0.41

Key:

- = not applicable

CP = comprehensive plan

Table 2-12. Physical Features for Proposed Road Relocations by Major Road Focus Area – CP1

Road Relocation Features	Relocation Amounts
Lakeshore Drive	
Length (linear feet)	8,075
Clearing and Grubbing (acres)	4
Excavation to Embankment (cubic yards)	46,100
Embankment Fill (cubic yards)	95,875
Number of Road Segments Affected	4
Closure Expected	No
Turntable Bay Area	
Length (linear feet)	6,190
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	19,000
Embankment Fill (cubic yards)	71,500
Number of Road Segments Affected	3
Closure Expected	Yes
Gillman Road	
Length (linear feet)	-
Clearing and Grubbing (acres)	-
Excavation to Embankment (cubic yards)	-
Embankment Fill (cubic yards)	-
Number of Road Segments Affected	-
Closure Expected	-
Jones Valley and Silverthorn Area	
Length (linear feet)	1,950
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	0
Embankment Fill (cubic yards)	41,250
Number of Road Segments Affected	1
Closure Expected	Yes
Salt Creek Road	
Length (linear feet)	-
Clearing and Grubbing (acres)	-
Excavation to Embankment (cubic yards)	-
Embankment Fill (cubic yards)	-
Number of Road Segments Affected	-
Closure Expected	-
Remaining Road Relocations	
Length (linear feet)	229
Clearing and Grubbing (acres)	0.4
Excavation to Embankment (cubic yards)	15
Embankment Fill (cubic yards)	34,231
Number of Road Segments Affected	2
Closure Expected	No

Key:
 - = not applicable
 CP = comprehensive plan

Table 2-13. Recreation Facilities to Be Modified or Relocated – CP1

Recreation Facilities	No. of Impacted Facilities	Relocation Needed¹
Marinas/Boat Ramps	9/6	8.5 acres
Resorts/Campground and Day-Use Areas	6/202	48.7 acres
Trailheads	2	2
Trails	-	8.1 miles

Note:

¹Does not include on-site modification of facilities.

Key:

- = not applicable

CP = comprehensive plan

**Table 2-14. Recreation and Nonrecreation
Demolition and Construction Material Quantities – CP1**

Material	Quantity
Recreation Facilities	
Imported Fill (cubic yards)	236,182
Excavation to Waste (cubic yards)	592,276
Demolition (cubic yards)	99,240
Nonrecreation Structures	
Demolition (cubic yards)	8,710

Key:

CP = comprehensive plan

Table 2-15. Physical Features for Proposed Utilities Relocations – CP1

Utility Type	Relocation Amounts
Potable Water Facilities	
Length of Waterlines Relocated (linear feet)	7,210
Wells/Tanks Relocated (number)	12
Pump Stations Relocated (number)	2
Length of Waterline Demolished (linear feet)	8,910
Wells/Tanks Demolished (number)	16
Pump Stations Demolished (number)	2
Gas/Petroleum Facilities	
Tanks Relocated (number)	7
Tanks Demolished (number)	7
Wastewater Facilities	
Septic Systems Relocated ¹ (number)	14
Vault/Pit Toilets Relocated (number)	2
Pump Stations Relocated (number)	1
Length of Wastewater Pipe Relocated (linear feet)	430
Septic Systems Demolished ² (number)	211
Vault/Pit Toilets Demolished (number)	2
Pump Stations Demolished (number)	2
Length of Wastewater Pipe Demolished (linear feet)	2,340
Package Wastewater Treatment Plants ³ (number)	Up to 6
Power Distribution Facilities	
Power Lines Relocated (linear feet)	30,260
Power Towers Relocated (number)	6
Power Lines Demolished (linear feet)	26,397
Power Towers Demolished (number)	6
Telecommunications	
Copper Wire Relocated (linear feet)	27,925
Fiber-Optic Cable Relocated (linear feet)	4,300
Copper Wire Demolished (linear feet)	23,575
Fiber-Optic Cable Demolished (linear feet)	3,640

Note:

¹ Does not include septic systems replaced with new sewer connections.

² Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.

³ Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.

Key:

CP = comprehensive plan

Operations and Maintenance for CP1

Shasta Dam is operated in conjunction with other CVP facilities to manage floodwater, storage of surplus winter runoff for irrigation in the Sacramento and San Joaquin valleys, M&I use, maintenance of navigation flows, protection and conservation of fish in the Sacramento River and Delta, and generation of hydroelectric energy. Storage in Shasta Reservoir fluctuates greatly throughout the year; storage is typically highest at the end of winter, in April and May, as the need for flood control reservation space in the reservoir decreases. Storage is typically at its lowest in September and October, after the irrigation season and before winter refill begins. Shasta Reservoir capacity is currently 4,552 TAF, with a maximum objective release capacity of 79,000 cfs. The end-of-September storage target for Shasta Reservoir is 1,900 TAF, except in the driest 10 percent of water years, to conserve sufficient cold water for meeting temperature criteria for the winter-run Chinook incubation period (summer to early fall). Storage levels are lowest by October to provide sufficient flood risk reduction and capture capacity during the following wet months. The storage target gradually increases from October to full pool in May; storage is then withdrawn for high water demand (agricultural, M&I, fishery, and water quality uses, etc.) during summer.

A series of rules and regulations in the form of flow requirements, water quality requirements, water supply commitments, and flood control requirements governs operations at Shasta Reservoir. Federal and State laws, regulations, standards, and plans regulating Shasta Dam operations are described in detail in Chapter 6, “Hydrology, Hydraulics, and Water Management,” and include the following:

- NMFS 2004 Operations Criteria and Plan Biological Opinion (NMFS 2004)
- CVPIA (Reclamation 1999)
- CVP long-term water service contracts (see *Hydrology, Hydraulics, and Water Management Technical Report*, Table 1-25)
- Trinity River ROD (Reclamation 2000)
- Flow objective for navigation at Wilkins Slough (Reclamation 2004)
- Flood management requirements in accordance with the Water Control Manual (USACE 1997)
- SWRCB Orders 90-05 and 91-01
- 1960 DFG Reclamation Memorandum of Agreement (DFG 1960)

- Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary (SWRCB 1995)
- SWRCB Water Right Revised Decision 1641 (SWRCB 2000)
- Coordinated Operations Agreement (Reclamation and DWR 1986)

Under CP1, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for water supply reliability and as an expanded cold-water pool for fisheries benefits. For CP1, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would be released for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not required for water supply purposes.

At a base level, CP1 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool, thus benefiting fisheries. Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP1 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur under Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

2.4.6 Comprehensive Plan 2 (CP2) – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 consists primarily of enlarging Shasta Dam by raising the crest 12.5 feet and enlarging the reservoir by 443,000 acre-feet.

Major Components of CP2

CP2 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 12.5 feet.

- Implementing the set of eight common management measures previously described.

A dam raise of 12.5 feet was chosen because it represents a midpoint between the likely smallest dam raise considered and the largest practical dam raise that would not require relocating the Pit River Bridge. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,090.0, CP2 would increase the height of the reservoir's full pool by 14.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to CP1. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF. Table 2-8 summarizes physical features that would be associated with the CP2 dam raise.

Under CP2, operations for water supply, hydropower, and environmental requirements would be similar to existing operations, with the additional storage retained for water supply reliability and as an expanded cold-water pool for fisheries benefits. The existing TCD would be extended for efficient use of the expanded cold-water pool.

As described for CP1, this alternative would also include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

Potential Benefits of CP2

Major potential benefits of CP2, related to contributions to the SLWRI objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. CP2 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critically dry water years. This would be accomplished by raising Shasta Dam 12.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBDD. It is estimated that improved water temperature conditions under CP2 could result in an average annual increase in the salmon population of about 234,000 out-migrating juvenile Chinook salmon.

Increase Water Supply Reliability CP2 would increase water supply reliability by increasing firm water supplies for irrigation and M&I deliveries

primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA, which would help reduce estimated future water shortages by increasing the reliability of firm water supplies for agricultural and M&I deliveries by at least 105,100 acre-feet per year and average annual yield by about 62,800 acre-feet per year. For this PDEIS, firm yield is considered equivalent to the estimated increase in the reliability of supplies during dry and critically dry periods. The majority of increased firm yield (85,300 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP2, approximately \$3.1 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 68 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities.

Maintain and Improve Recreation Opportunities CP2 includes features to, at minimum, maintain the existing recreation capacity at Shasta Lake. Although CP2 does not have specific features to further benefit recreation resources, a small benefit would likely occur to the water-oriented recreation experience at Shasta Lake due to the increase in lake surface area and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,750 acres (6 percent), from 29,600 acres to about 31,300 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by raising the bottom of the flood control pool elevation and allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Objectives CP2 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Construction for CP2

Construction activities for CP2 are described in Section 2.4.2, “Construction Activities Common to All Action Alternatives.” Information specific to CP2 construction activities is summarized in Tables 2-16 through 2-22.

Table 2-16. Reservoir Clearing Treatment Applied – CP2

Landing	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)
Antlers	12	76,600	8	52,700
Bailey Cove	26	234,000	11	64,000
Beehive Point	4	8,500	38	161,300
Bridge Bay	14	81,600	0	0
Digger Bay	13	43,700	49	146,000
Hirz Bay	35	333,000	34	267,300
Jones Valley	26	128,800	81	517,100
Lakeshore East	27	92,800	4	19,700
Lower Salt Creek	22	151,800	24	98,900
McCloud Arm	7	23,500	0	0
Packers Bay	11	46,000	35	124,200
Pit Arm	3	35,300	0	0
Shasta Marina	2	28,200	21	141,000
Silverthorn	26	185,900	29	181,400
Turntable	8	52,200	13	139,900
Total	236	1,521,900	347	1,913,500

Key:
CP = comprehensive plan

Table 2-17. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances – CP2

Physical Features	Quantities
Quantity of Concrete (cubic yards)	77,314
Quantity of Cement (tons)	170,500
Quantity of Metalwork (pounds)	20,435,889
Volume of Imported Fill Material (cubic yards)	94,420
Volume of Excavation to Waste Material (cubic yards)	1,610
Quantity of Demolished Material (cubic yards)	29,202
Area of Permanent Structures (square feet)	412,570
Area of Work Limits (square feet)	460,920

Key:
CP = comprehensive plan

Table 2-18. Physical Features for Proposed Dikes – CP2

Dike Features	Quantities
Lakeshore Dikes	
Doney Creek Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	12,246
Volume of Riprap (cubic yards)	980
Volume of Excavated Material (cubic yards)	3,108
Site Clearing and Grubbing Below Dike (acres)	1.5
Antlers Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	-
Volume of Riprap (cubic yards)	-
Volume of Excavated Material (cubic yards)	-
Site Clearing and Grubbing Below Dike (acres)	-
North Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	17,142
Volume of Riprap (cubic yards)	410
Volume of Excavated Material (cubic yards)	1,503
Site Clearing and Grubbing Below Dike (acres)	1.15
Middle Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	13,350
Volume of Riprap (cubic yards)	320
Volume of Excavated Material (cubic yards)	3,985
Site Clearing and Grubbing Below Dike (acres)	2.88
South Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	101,942
Volume of Riprap (cubic yards)	2,460
Volume of Excavated Material (cubic yards)	8,503
Site Clearing and Grubbing Below Dike (acres)	6.22
Bridge Bay Dikes	
West Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	7,661
Volume of Riprap (cubic yards)	780
Volume of Excavated Material (cubic yards)	4,967
Site Clearing and Grubbing Below Dike (acres)	1.38
East Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	3,007
Volume of Riprap (cubic yards)	160
Volume of Excavated Material (cubic yards)	2,002
Site Clearing and Grubbing Below Dike (acres)	0.63

Key:

- = not applicable

CP = comprehensive plan

Table 2-19. Physical Features for Proposed Road Relocations by Major Road Focus Area – CP2

Road Relocation Features	Relocation Amounts
Lakeshore Drive	
Length (linear feet)	13,063
Clearing and Grubbing (acres)	7
Excavation to Embankment (cubic yards)	55,100
Embankment Fill (cubic yards)	145,875
Number of Road Segments Affected	6
Closure Expected	No
Turntable Bay Area	
Length (linear feet)	6,190
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	19,100
Embankment Fill (cubic yards)	71,500
Number of Road Segments Affected	3
Closure Expected	Yes
Gillman Road	
Length (linear feet)	1,246
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	0
Embankment Fill (cubic yards)	28,500
Number of Road Segments Affected	3
Closure Expected	Yes
Jones Valley and Silverthorn Area	
Length (linear feet)	1,950
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	0
Embankment Fill (cubic yards)	41,250
Number of Road Segments Affected	1
Closure Expected	Yes
Salt Creek Road	
Length (linear feet)	4,325
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	4,050
Embankment Fill (cubic yards)	34,563
Number of Road Segments Affected	4
Closure Expected	Yes
Remaining Road Relocations	
Length (linear feet)	2,280
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	120
Embankment Fill (cubic yards)	76,126
Number of Road Segments Affected	4
Closure Expected	No

Key:
CP = comprehensive plan

Table 2-20. Recreation Facilities to Be Modified or Relocated – CP2

Recreation Facilities	No. of Impacted Facilities	Relocation Needed¹
Marinas/Boat Ramps	9/6	8.5 acres
Resorts/Campground and Day Use Areas	6/261	50.9 acres
Trailheads	2	2
Trails	-	9.9 miles

Note:

¹ Does not include on-site modification of facilities

Table 2-21. Recreation Facilities Demolition and Construction Material Quantities – CP2

Material	Quantity
Recreation Facilities	
Imported Fill (cubic yards)	384,191
Excavation to Waste (cubic yards)	430,584
Demolition (cubic yards)	102,076
Nonrecreation Structures	
Demolition (cubic yards)	21,450

Key:

CP = comprehensive plan

Table 2-22. Physical Features for Proposed Utilities Relocations – CP2

Utility Type	Relocation Amounts
Potable Water Facilities	
Length of Waterlines Relocated (linear feet)	8,450
Wells/Tanks Relocated (number)	13
Pump Stations Relocated (number)	2
Length of Waterline Demolished (linear feet)	11,220
Wells/Tanks Demolished (number)	28
Pump Stations Demolished (number)	2
Gas/Petroleum Facilities	
Tanks Relocated (number)	10
Tanks Demolished (number)	10
Wastewater Facilities	
Septic Systems Relocated ¹ (number)	19
Vault/Pit Toilets Relocated (number)	2
Pump Stations Relocated (number)	1
Length of Wastewater Pipe Relocated (linear feet)	430
Septic Systems Demolished ² (number)	239
Vault/Pit Toilets Demolished (number)	2
Pump Stations Demolished (number)	2
Length of Wastewater Pipe Demolished (linear feet)	2,340
Package Wastewater Treatment Plants ³ (number)	Up to 6
Power Distribution Facilities	
Power Lines Relocated (linear feet)	36,305
Power Towers Relocated (number)	6
Power Lines Demolished (linear feet)	33,705
Power Towers Demolished (number)	6
Telecommunications	
Copper Wire Relocated (linear feet)	30,205
Fiber-Optic Cable Relocated (linear feet)	5,840
Copper Wire Demolished (linear feet)	27,810
Fiber-Optic Cable Demolished (linear feet)	5,180

Note:

¹ Does not include septic systems replaced with new sewer connections.

² Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.

³ Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.

Key:

CP = comprehensive plan

Operations and Maintenance for CP2

Operations under CP2 are governed by the same regulatory constraints as described for CP1. Similar to CP1, under CP2, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for water supply reliability and to create an expanded cold-water pool for fisheries. For CP2, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would be released for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not usable for water supply purposes.

At a base level, CP2 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool, thus benefiting fisheries. Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP2 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur with Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

2.4.7 Comprehensive Plan (CP3) – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP3 consists primarily of enlarging Shasta Dam by raising the dam crest 18.5 feet and enlarging the reservoir by 634,000 acre-feet.

Major Components of CP3

CP3 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Implementing the set of eight common management measures previously described.

By raising Shasta Dam 18.5 feet, from a crest at elevation 1,077.5 to elevation 1,096.0, CP3 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise

height would result from spillway modifications similar to CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.19 MAF. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and costly reservoir area relocations, such as relocating the Pit River Bridge, I-5, and the Union Pacific Railroad tracks. Table 2-8 summarizes major components that would be associated with the CP3 dam raise.

Under CP3, operations for water supply, hydropower, and environmental requirements would be similar to existing operations, with the additional storage retained for water supply reliability and as an expanded cold-water pool for fisheries benefits. The existing TCD would be extended for efficient use of the expanded cold-water pool.

As described for the above alternatives, this alternative would also include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

Potential Benefits of CP3

Major potential benefits of CP3, related to contributions to the SLWRI objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. CP3 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critically water dry years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBDD. It is estimated that improved water temperature conditions under CP3 could result in an average annual increase in the Chinook salmon population of about 607,000 out-migrating juvenile fish.

Increase Water Supply Reliability CP3 would increase water supply reliability by increasing firm water supplies for irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA, which would help reduce estimated future water shortages by increasing the reliability of firm water supplies for agricultural and M&I deliveries by at least 133,400 acre-feet per year and average annual yield by about 75,800 acre-feet per year. For this PDEIS, firm yield is considered equivalent to the estimated increase in the

reliability of supplies during dry and critically dry periods. The majority of increased firm yield (103,800 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP3, approximately \$3.8 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 96 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities.

Maintain and Increase Recreation Opportunities CP3 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although CP3 does not include specific features to further benefit recreation resources, a small benefit would likely occur to the water-oriented recreation experience at Shasta Lake due to the increase in lake surface area and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,500 acres (8 percent), from 29,600 acres to about 32,100 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by raising the bottom of the flood control pool elevation and allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP3 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Construction for CP3

Construction activities for CP3 are described in Section 2.4.2, “Construction Activities Common to All Action Alternatives.” Information specific to CP3 construction activities is summarized in Tables 2-23 through 2-29.

Table 2-23. Reservoir Clearing Treatment Applied – CP3, CP4, and CP5

Landing	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)
Antlers	17	109,300	12	75,100
Bailey Cove	37	333,700	15	91,300
Beehive Point	6	12,100	54	230,100
Bridge Bay	20	116,400	0	0
Digger Bay	19	62,400	70	208,300
Hirz Bay	49	474,900	49	381,200
Jones Valley	38	183,700	116	737,500
Lakeshore East	39	132,300	5	28,100
Lower Salt Creek	31	216,500	35	141,100
McCloud Arm	10	33,500	0	0
Packers Bay	16	65,600	50	177,100
Pit Arm	4	50,400	0	0
Shasta Marina	2	40,200	30	201,100
Silverthorn	37	265,200	41	258,800
Turntable	11	74,400	19	199,500
Total	337	2,170,600	495	2,729,200

Key:
CP = comprehensive plan

Table 2-24. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances – CP3, CP4, and CP5

Physical Features	Quantities
Quantity of Concrete (cubic yards)	100,811
Quantity of Cement (tons)	213,039
Quantity of Metalwork (pounds)	21,751,199
Volume of Imported Fill Material (cubic yards)	130,470
Volume of Excavation to Waste Material (cubic yards)	1,610
Quantity of Demolished Material (cubic yards)	25,377
Area of Permanent Structures (square feet)	412,570
Area of Work Limits (square feet)	460,920

Key:
CP = comprehensive plan

Table 2-25. Physical Features for Proposed Dikes – CP3, CP4, and CP5

Dike Features	Quantities
Lakeshore Dikes	
Doney Creek Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	75,040
Volume of Riprap (cubic yards)	5,920
Volume of Excavated Material (cubic yards)	10,190
Site Clearing and Grubbing Below Dike (acres)	7.22
Antlers Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	4,910
Volume of Riprap (cubic yards)	380
Volume of Excavated Material (cubic yards)	340
Site Clearing and Grubbing Below Dike (acres)	0.92
North Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	17,145
Volume of Riprap (cubic yards)	410
Volume of Excavated Material (cubic yards)	1,503
Site Clearing and Grubbing Below Dike (acres)	1.15
Middle Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	13,350
Volume of Riprap (cubic yards)	320
Volume of Excavated Material (cubic yards)	3,985
Site Clearing and Grubbing Below Dike (acres)	2.88
South Railroad Dike	
Volume of Fill Material (core, filter) (cubic yards)	101,945
Volume of Riprap (cubic yards)	2,460
Volume of Excavated Material (cubic yards)	8,503
Site Clearing and Grubbing Below Dike (acres)	6.22
Bridge Bay Dikes	
West Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	69,000
Volume of Riprap (cubic yards)	23,630
Volume of Excavated Material (cubic yards)	15,280
Site Clearing and Grubbing Below Dike (acres)	2.2
East Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	40,100
Volume of Riprap (cubic yards)	7,440
Volume of Excavated Material (cubic yards)	16,880
Site Clearing and Grubbing Below Dike (acres)	1.12

Key:
CP = comprehensive plan

Table 2-26. Physical Features for Proposed Road Relocations by Major Road Focus Area – CP3, CP4, and CP5

Road Relocation Features	Relocation Amounts
Lakeshore Drive	
Length (linear feet)	13,743
Clearing and Grubbing (acres)	7
Excavation to Embankment (cubic yards)	55,500
Embankment Fill (cubic yards)	149,250
Number of Road Segments Affected	8
Closure Expected	No
Turntable Bay Area	
Length (linear feet)	6,190
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	19,000
Embankment Fill (cubic yards)	71,500
Number of Road Segments Affected	3
Closure Expected	Yes
Gillman Road	
Length (linear feet)	1,246
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	0
Embankment Fill (cubic yards)	28,500
Number of Road Segments Affected	3
Closure Expected	Yes
Jones Valley and Silverthorn Area	
Length (linear feet)	3,562
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	1,500
Embankment Fill (cubic yards)	54,500
Number of Road Segments Affected	4
Closure Expected	Yes
Salt Creek Road	
Length (linear feet)	5,108
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	5,540
Embankment Fill (cubic yards)	34,563
Number of Road Segments Affected	5
Closure Expected	Yes
Remaining Road Relocations	
Length (linear feet)	3,939
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	620
Embankment Fill (cubic yards)	89,251
Number of Road Segments Affected	7
Closure Expected	No

Key:
CP = comprehensive plan

Table 2-27. Recreation Facilities to Be Modified or Relocated – CP3, CP4, and CP5

Recreation Facilities	No. of Impacted Facilities	Relocation Needed¹	CP5 Additional Recreation Enhancement²
Marinas/Boat Ramps	9/6	8.5 acres	-
Resorts/Campground and Day-Use Areas	6/328	56 acres	-
Trailheads	2	2	6
Trails	-	11.6 miles	18 miles

Notes:

¹Does not include on-site modification of facilities.

²Additional recreation facilities for Alternative CP5 only.

Key:

- = not applicable

CP = comprehensive plan

Table 2-28. Recreation Facilities Demolition and Construction Material Quantities – CP3, CP4, and CP5

Material	Quantity
Recreation Facilities	
Imported Fill (cubic yards)	552,829
Excavation to Waste (cubic yards)	315,396
Demolition (cubic yards)	105,220
Nonrecreation Structures	
Demolition (cubic yards)	26,960

Key:

CP = comprehensive plan

Table 2-29. Physical Features for Proposed Utilities Relocations for CP3, CP4, and CP5

Utility Type	Relocation Amounts
Potable Water Facilities	
Length of Waterlines Relocated (linear feet)	11,045
Wells/Tanks Relocated (number)	10
Pump Stations Relocated (number)	3
Length of Waterline Demolished (linear feet)	14,790
Wells/Tanks Demolished (number)	25
Pump Stations Demolished (number)	3
Gas/Petroleum Facilities	
Tanks Relocated (number)	10
Tanks Demolished (number)	10
Wastewater Facilities	
Septic Systems Relocated ¹ (number)	19
Vault/Pit Toilets Relocated (number)	2
Pump Stations Relocated (number)	1
Length of Wastewater Pipe Relocated (linear feet)	430
Septic Systems Demolished ² (number)	266
Vault/Pit Toilets Demolished (number)	2
Pump Stations Demolished (number)	2
Length of Wastewater Pipe Demolished (linear feet)	2,370
Package Wastewater Treatment Plants ³ (number)	Up to 6
Power Distribution Facilities	
Power Lines Relocated (linear feet)	37,790
Power Towers Relocated (number)	6
Power Lines Demolished (linear feet)	36,185
Power Towers Demolished (number)	6
Telecommunications	
Copper Wire Relocated (linear feet)	33,380
Fiber-Optic Cable Relocated (linear feet)	5,840
Copper Wire Demolished (linear feet)	31,245
Fiber-Optic Cable Demolished (linear feet)	5,180

Note:

¹ Does not include septic systems replaced with new sewer connections.

² Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.

³ Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.

Key:

CP = comprehensive plan

Operations and Maintenance for CP3

Operations under CP3 are governed by the same regulatory constraints as described for CP1. Similar to CP1, under CP3, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for water supply reliability and to create an expanded cold-water pool for fisheries. For CP3, existing water quality and temperature requirements would be met in most years; therefore, additional water in storage would be released for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not usable for water supply purposes.

At a base level, CP3 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool, thus benefiting fisheries. Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP3 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur with Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

2.4.8 Comprehensive Plan 4 (CP4) – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 focuses on increasing anadromous fish survival by raising Shasta Dam 18.5 feet while also increasing water supply reliability.

Major Components of CP4

CP4 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Reserving 378,000 acre-feet of the increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival.
- Augmenting spawning gravel in the upper Sacramento River.

- Restoring riparian, floodplain, and side channel habitat.
- Implementing the set of eight common management measures previously described.

By raising Shasta Dam 18.5 feet, from a crest at elevation 1,077.5 to elevation 1,096.0, CP4 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF.

The additional storage created by the 18.5-foot dam raise would be used to both improve the ability to meet temperature objectives for winter-run Chinook salmon and to meet habitat requirements for other anadromous fish during drought years and increase water supply reliability. Of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Table 2-8 summarizes major components that would be associated with the CP4 dam raise.

Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool.

As described for the above alternatives, this alternative also would include the potential to revise the operational rules for flood control for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

CP4 also includes an adaptive management plan for the cold-water pool, and augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

Adaptive Management of Cold-Water Pool The adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam to benefit anadromous fish, as long as there are no conflicts with current operational guidelines or adverse impacts to water supply reliability. Further discussion regarding adaptive management of the cold-water pool for anadromous fish is included below under "Operations and Maintenance."

Augment Spawning Gravel in Upper Sacramento River Gravel suitable for spawning has been identified as a significant influencing factor in the recovery of anadromous fish populations in the Sacramento River (USFWS 2001, NMFS 2009). Under CP4, spawning-sized gravel would be placed at multiple locations along the Sacramento River between Keswick Dam and the RBDD.

Gravel augmentation would occur at one to three locations every year, for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. This program, in combination with the ongoing CVPIA gravel augmentation program, would help address the gravel debt in the upper Sacramento River, but this reach may continue to be gravel-starved into the future. Therefore, the gravel augmentation program proposed herein would be reevaluated after the 10-year period to assess the need for continued spawning gravel augmentation, and to identify opportunities for future actions or programs to do so.

On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Gravel would be obtained as uncrushed, rounded river rock, free of debris and organic material, from local, commercial sources. To maximize the benefit to anadromous fish, gravel would be washed and sorted to meet specific size criteria. To minimize impacts to salmonid spawning activity, gravel applied to active river channels would be placed between August and September each year, consistent with the time frame for the ongoing CVPIA gravel augmentation program.

Fifteen preliminary locations for spawning gravel augmentation were identified in the Sacramento River between Keswick Dam and Shea Island. Each site would be eligible for gravel placement one or more times during the 10-year program. Selection of these locations was based on potential benefits to anadromous fish and site accessibility. Gravel placement would provide either immediate spawning habitat or long-term recruitment.

Although preliminary sites have been identified, specific gravel augmentation site(s) and volume(s) would be selected each year in the spring or early summer through discussions among Reclamation, USFWS, DFG, and NMFS. The discussions would include topics such as avoiding redundancy with planned CVPIA gravel augmentation activities in a given year; identifying hydrology or morphology issues that could impact the potential benefit of placing gravel at any particular site; identifying changes in spawning trends due to previous years' gravel augmentation activities; evaluating potential new sites; and appropriately distributing selected gravel sites along the river reach(es).

Restore Riparian, Floodplain, and Side Channel Habitat Under CP4, riparian, floodplain, and side channel habitat restoration would be constructed at a suitable location along the Sacramento River. The exact size, scope, and location of a suitable restoration site is still under development and will be provided future versions of this EIS (Draft EIS and/or FEIS). A description of potential of riparian, floodplain, and side channel habitat restoration at Reading Island is provided below as an example restoration project. Restoration activities anticipated under CP4 are expected to be similar in size and scope to those described below.

Reading Island lies along the Sacramento River just north of Cottonwood Creek in Shasta County at River Mile 274. Reading Island is approximately 269 acres in area, with 46 acres on the south end of the island owned by U.S. Bureau of Land Management and managed as a day-use park (Figure 2-6). The remaining 223 acres are privately owned. The island is accessible by Adobe Road and a bridge crossing over the Anderson Creek Slough into the U.S. Bureau of Land Management day-use park. Historically, the channel that now forms the slough supported important habitat for anadromous salmonids, including rearing habitat for winter-run Chinook and spawning habitat for Central Valley steelhead.

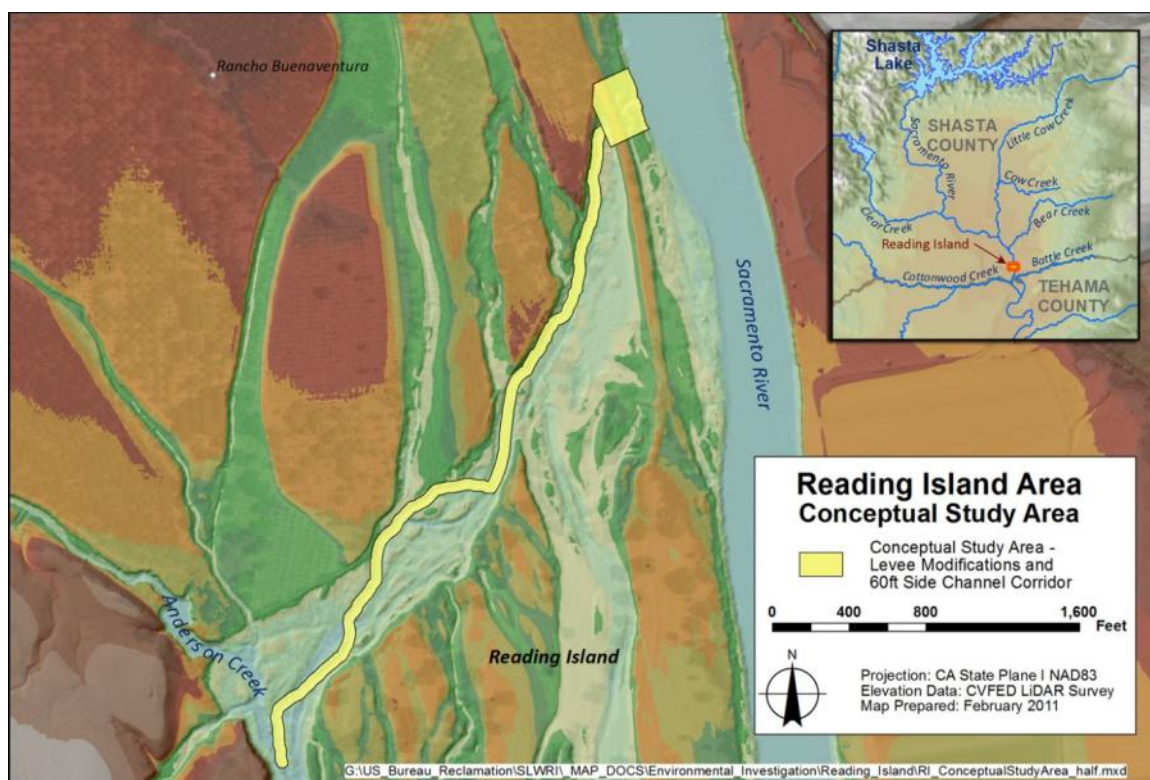


Figure 2-6. Reading Island Conceptual Study Area

At the Reading Island site, an approximately 0.8-mile-long historic Sacramento River channel/floodplain scour channel/side channel (hereafter referred to as “side channel”) drains into the present-day Anderson Creek, a remnant Sacramento River side channel. Anderson Creek flows approximately 1.5 miles and then enters the Sacramento River about 0.3 miles upstream from Cottonwood Creek. Average channel width of the side channel is approximately 30 feet.

The Anderson Creek Slough, into which Anderson Creek empties, was blocked at the upstream end in the early 1970s by construction of a levee on the adjoining private property. A few years after construction of the levee, the slough became choked with various species of water plants, primarily primrose

creeper (*Ludwigia peploides*). Before levee construction, the Anderson Creek Slough captured a portion of the Sacramento River flow and functioned as side channel habitat.

After levee construction, water velocity in the side channel slowed substantially and water temperatures increased. Primrose creeper and warm-water nonnative fish species established within the channel. Currently, most of the water entering the slough comes from Anderson Creek and drainage wastewater from irrigation canals. An earthen embankment with two 36-inch-diameter culverts now restricts the flow of water into the side channel. The water surface elevation of the Sacramento River, with a flow rate of 8,500 cfs, is at the approximate elevation of the invert of the culverts, but even when discharge in the Sacramento River increases to approximately 12,000 cfs, there is minimal flow through the culverts into the side channel. Above the slough, Anderson Creek is known to provide rearing habitat for winter-run Chinook, and is managed for steelhead spawning habitat.

Floodplain, riparian, and side channel habitat restoration would involve acquiring property on Reading Island and revegetating floodplain terraces and adjacent riparian areas with native plants. In addition, the Reading Island side channel could be activated over a wider range of flows to provide juvenile salmonid rearing habitat in the side channel, and in Anderson Creek at the downstream end of the side channel. This would be accomplished by breaching the levee at the upstream end of the side channel to restore connectivity with the Sacramento River at flows greater than 4,000 to 6,000 cfs. Preliminary analysis indicates that in addition to breaching the levee, side channel clearing and excavation may be necessary to restore flows capable of supporting suitable spawning habitat. This would include vegetation and debris removal and deepening of the existing channel. At a maximum, side channel clearing and excavation would be performed along the entire 0.8-mile channel, requiring the removal of about 15,560 cubic yards of material.

Planting mix, composition, and density would be determined by a more detailed site analysis, but could include native cottonwood, willow, box elder, valley oak, western sycamore, elderberry, and a variety of understory brush species. Temporary irrigation would be provided on an as-needed basis with a temporary well powered from an existing nearby power supply. The revegetated areas are expected to develop into self-sustaining riparian habitats within 1 to 4 years of initial planting, based on results of previous riparian restoration projects along the Sacramento River. Regraded floodplain areas are expected to change over time depending on hydrologic conditions, but it is anticipated that no elements of this measure would need to be replaced or reapplied during the 50-year project life. The site would be fenced to reduce the potential for access by livestock.

Potential Benefits of CP4

Major potential benefits of CP4, related to the SLWRI objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. CP4 would significantly increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critically dry water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBDD. It is estimated that improved water temperature conditions under CP4 could result in an average annual increase in Chinook salmon population of nearly 1,199,000 out-migrating juvenile fish.

Under CP4, an increase in the cold-water pool would allow Reclamation to operate Shasta Reservoir to provide not only a more reliable source of water during dry and critical water years, but also to provide more cool water for release into the Sacramento River to improve conditions for anadromous fish. Of the increased storage space, about 378,000 acre-feet (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes.

In addition, CP4 includes a gravel augmentation program. Gravel augmentation would occur on average at one or more locations in the Sacramento River between Keswick Dam and the RBDD for a period of 10 years and, on average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Spawning gravel augmentation is expected to positively influence anadromous fish populations in the Sacramento River.

Increase Water Supply Reliability CP4 would increase water supply reliability by increasing firm water supplies for irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA, which would help reduce estimated future water shortages by increasing the reliability of firm water supplies for agricultural and M&I deliveries by at least 76,400 acre-feet per year and average annual yield by about 46,400 acre-feet per year. For this PDEIS, firm yield is considered equivalent to the estimated increase in the reliability of supplies during dry and critically dry periods. The majority of increased firm yield (66,800 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future

water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP4 approximately \$2.3 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 138 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities.

Conserve, Restore, and Enhance Ecosystem Resources In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat are expected to improve the complexity of aquatic habitat and its suitability for spawning and rearing. Riparian areas provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous threatened or endangered species. Riparian areas also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. In addition, improved fisheries conditions as a result of cold-water carryover storage in CP4, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Side channels can support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities CP4 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Potential recreation benefits would be as stated for CP3. The maximum surface area of the lake would increase by about 2,500 acres (8 percent), from 29,600 acres to about 32,100 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by raising the bottom of the flood control pool elevation and allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Objectives CP4 could also provide benefits related to flood damage reduction and water quality, similar to CP1.

Construction for CP4

Construction activities related to enlarging the reservoir under CP4 are identical to those described for CP3, and are summarized in Tables 2-23 through 2-29. Additional construction effort would be required for the proposed spawning gravel augmentation, as described below.

Gravel augmentation would occur at one to three locations every year for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. Construction activities would vary significantly by location, but generally would include clearing, grubbing, and some grading of new access routes to allow construction vehicles to access the river. At several sites, clearing and grubbing of the riverbank would be required to allow gravel to be placed on the bank for recruitment. Gravel would be delivered to the sites by dump trucks. In most cases, gravel would be stockpiled in a staging area and moved with bulldozers, loaders, and/or excavators. Dust control trucks would be present at all times when gravel is on site.

Several sites would require in-water construction work. Generally, this involves gravel being built out into the river channel “step-wise,” meaning gravel is dumped and leveled, and the leveled area serves as a working platform for the next step of construction. This practice is common for spawning gravel placement, and minimizes the extent to which construction vehicles drive directly through an active river channel. One or two sites, however, would require construction activity in the active river channel, where construction vehicles would deposit gravel and grade a submerged riffle.

Riparian, Floodplain, and Side Channel Habitat Restoration Riparian, floodplain, and side channel habitat restoration at Reading Island would involve acquiring and revegetating floodplain terraces and adjacent riparian areas with native plants, and breaching the levee at the upstream end of the side channel. Planting mix, composition, and density would be determined by a more detailed site analysis, but could include native cottonwood, willow, box elder, valley oak, western sycamore, elderberry, and a variety of understory brush species.

Breaching the levee would include the use of an excavator, loader, and compaction equipment. For a 3:1 cut through the levee down to the invert elevations of the culvert, with a 60-foot-wide base, approximately 7,901 cubic yards of earthen material would be excavated. If side channel clearing and excavation are necessary, clearing would be performed along the 0.8-mile channel over a maximum average width of 30 feet plus an additional 10 feet for construction equipment access, covering a maximum area of 3.9 acres. Excavation would involve a maximum average width and depth of 20 and 5 feet, respectively, along the length of the channel for a maximum of 15,560 cubic yards of material removal. The transport of excavated material would likely be accomplished with loader and dump trucks. Excavated materials would be taken off site to commercially available, approved locations for safe storage, use, and/or disposal. A mechanical harvester would be used to remove

invasive aquatic vegetation from the side channel and Anderson Slough. In-water construction is expected to take place during periods of low flow in the Sacramento River (October to November) to minimize water quality impacts. Further construction methods, staging areas, and borrow sites would be identified by Reclamation and included in future versions of this document (Draft EIS or FEIS).

Operations and Maintenance for CP4

Operations under CP4 are governed by the same regulatory constraints as described for CP1. Similar to CP1, Shasta Dam operational guidelines would continue unchanged under CP4, with the additional storage retained for water supply reliability and to create an expanded cold-water pool for fisheries. Of the 634,000 acre-feet of additional storage, 378,000 acre-feet of water (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. This would be in addition to any storage targets set by regulations described in Chapter 6, “Hydrology, Hydraulics, and Water Management.”

As modeled, the 378,000 acre-feet of additional water would be the first increment of the reservoir filled after the reservoir was enlarged, and would be available as additional water for the cold-water pool each year regardless of water year type, unless Reclamation elected to use the additional water to augment flows protecting anadromous fish in the Sacramento River, as part of a proposed adaptive management plan, as explained below. An additional 256,000 acre-feet of the increased storage space would primarily be used to improve water supply reliability; operations of Shasta Dam related to the 256,000 acre-feet of storage would be identical to CP1.

As stated above, of the total 634,000 acre-feet of additional storage, 378,000 acre-feet of water would be used to increase the cold-water pool for fisheries. The additional 378,000 acre-feet of cold-water pool would be managed by Reclamation in coordination with the Sacramento River Temperature Task Group (SRTTG). Reclamation is currently working with NMFS, USFWS, and DFG through the SRTTG, which is a multiagency group established to adaptively manage flows and water temperatures in the Sacramento River to improve and stabilize Chinook salmon populations in the upper Sacramento River.

Current analysis indicates that the most beneficial use of the additional 378,000 acre-feet of storage for fisheries protection is as an expanded cold-water pool; however, Reclamation has agreed to adaptively manage the 378,000 acre-feet of water, as appropriate, to increase benefits to anadromous fish as part of CP4. Adaptive management is an approach allowing decision makers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics. Adaptive management, if applied appropriately, allows for flexible operations based on best available science and new information as it becomes available.

The adaptive management plan may include operational changes to the timing and magnitude of releases primarily to improve the quality and quantity of aquatic habitat. These changes may include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional 378,000 acre-feet of water in storage to meet temperature requirements. Reclamation would work cooperatively with the SRTTG to determine the best use of the cold-water pool each year under an adaptive management plan. Reclamation would manage the cold-water pool and operate Shasta Dam each year based on recommendations from the SRTTG. Because adaptive management is predicated on using best available science and new information to make decisions, a monitoring program would be implemented as part of the adaptive management plan. SRTTG would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

Currently, the 378,000 acre-feet of additional storage would be the first increment of water in the reservoir to fill after dam enlargement, and would be available each year independent of water year type if used exclusively to enlarge the cold-water pool. If the 378,000 acre-feet of stored water is used to augment flows based on recommendations from the SRTTG, this water would not be guaranteed to be available for use the following year because of uncertainty in hydrologic conditions, although the potential to store the water, if available, would remain. Once water was released to augment flows as part of the adaptive management plan, the 378,000 acre-feet of additional storage space would be refilled after the 256,000 acre-feet of additional storage space was filled for the primary purpose of increasing water supply reliability. Each year that the 378,000 acre-feet of additional water was held in storage as part of an increase in the cold-water pool, the allocated amount would be available as long as the cold-water pool continued to provide benefits to fisheries.

Since SALMOD modeling and related analysis indicate that in most cases, providing an increased cold-water pool benefits Chinook salmon populations more than increasing flows, impacts and benefits of increasing flows under CP4 are not presented in this PDEIS. Per recommendations in Title 43 of the Code of Federal Regulations Part 46 Section 46.145, substantive increases in flows associated with the adaptive management plan would be evaluated in subsequent NEPA analysis.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

2.4.9 Comprehensive Plan 5 (CP5) – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increased water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and increased recreation opportunities.

Major Components of CP5

CP5 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (Sacramento River, McCloud River, and Squaw Creek).
- Constructing shoreline fish habitat around Shasta Lake.
- Augmenting spawning gravel in the upper Sacramento River.
- Restoring riparian, floodplain, and side channel habitat.
- Increasing recreation opportunities at Shasta Lake.
- Implementing the set of eight common management measures previously described.

By raising Shasta Dam 18.5 feet, from a crest at elevation 1,077.5 to elevation 1,096.0, CP5 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. Table 2-8 summarizes major components that would be associated with the CP5 dam raise.

Under CP5, operations for water supply, hydropower, and environmental requirements would be similar to existing operations, with the additional storage retained for water supply reliability and as an expanded cold-water pool for fisheries benefits. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool.

As described for the above alternatives, this alternative also would include the potential to revise the flood control operational rules for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

CP5 also includes (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the tributaries to Shasta Lake, (3) augmenting spawning gravel in the upper

Sacramento River, (4) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River, and (5) increasing recreation opportunities at Shasta Lake.

Construct Shoreline Enhancement The ecosystem enhancement goal for the shoreline environment of Shasta Lake is to improve warm-water fish habitat associated with the transition between the reservoir's aquatic and terrestrial habitats. Shoreline enhancement entails a range of enhancement opportunities along the Shasta Lake shoreline below the full pool elevation (1,090 feet) that would occur with an 18.5-foot dam raise. This area is typically between 0.1 and 1.5 miles upslope from the current full pool elevation of 1,070 feet. The shoreline is defined as the area encompassing nearshore aquatic habitat within the reservoir itself and vegetation and other habitat components adjacent to the reservoir.

Two categories of potential nearshore warm-water fish habitat enhancement activities are (1) structural enhancements, which entail placing artificial structures in the Shasta Lake littoral zone, and (2) vegetative enhancements, which entail planting and seeding to provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months.

Construction activities common to all action alternatives include stockpiling manzanita for fish habitat (see Section 2.4.2). CP5 would include clearing additional manzanita from above the new full pool inundation zone to create further structural enhancements for fish habitat in the Shasta Lake littoral zone.

Vegetative enhancements associated with CP5 would include planting willows (*Salix*) to enhance nearshore fish habitat, and single treatment aerial and hand seeding of annual cereal grains to treat shoreline areas at Shasta Lake. Treatment with cereal grains provides only short-term cover, but is cost-effective across large areas and can be implemented quickly and efficiently. The annual cereal grain grasses provide cover for young fish and also nutrients for plankton as the grasses decompose. The plankton in turn are a valuable food source for juvenile fish.

Construct Tributary Aquatic Habitat Enhancement The primary goal for the enhancement of aquatic habitat in the watershed is to improve the connectivity for native fish species and other aquatic organisms between Shasta Lake and its tributaries. Two categories of potential aquatic habitat enhancement in tributaries are (1) fish passage enhancements, which entail identifying and correcting barriers to fish passage, particularly at culverts and other human-made barriers, and (2) aquatic habitat enhancements, which entail identifying and implementing feasible habitat improvements intended to conserve or restore degraded aquatic and riparian habitat in tributaries to Shasta Lake.

Fish passage enhancements associated with CP5 include opportunities to restore and/or enhance five perennial stream crossings. Barriers to fish passage in the watersheds above Shasta Lake are primarily associated with culverts or other types of stream crossings.

Aquatic habitat enhancements associated with CP5 include enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams. The preliminary site survey identified opportunities to enhance 14 intermittent stream crossings. Based on the information obtained in the survey, these crossings provide opportunities for meeting the objectives of enhancing aquatic connectivity and/or reducing the potential for road-related sediment. Two sites have been identified in the Salt Creek watershed, two sites have been identified in the Sugarloaf Creek watershed, and ten sites have been identified in the McCloud Arm watershed.

Augment Spawning Gravel in Upper Sacramento River As described in CP4, spawning gravel will be added to the upper Sacramento River. This measure is identical to that proposed under CP4.

Restore Riparian, Floodplain, and Side Channel Habitat As described in CP4, riparian, floodplain, and side channel habitat restoration would be constructed at a suitable location along the Sacramento River. This measure is identical to that proposed under CP4.

Recreation Enhancements A total of 18 miles of new hiking trails and 6 trailheads would be constructed to enhance recreation under CP5. Descriptions have been developed for the trails and associated features, and are included in the Engineering Summary Appendix.

Potential Benefits of CP5

Major potential benefits of CP5, related to the SLWRI objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. CP5 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critically dry water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBDD. It is estimated that improved water temperature conditions under CP5 could result in an annual average increase in the Chinook salmon population of about 607,000 out-migrating juvenile fish.

Increase Water Supply Reliability CP5 would increase water supply reliability by increasing firm water supplies for irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA, which would help reduce estimated future water shortages by increasing the reliability of firm water supplies for agricultural and M&I deliveries by at least 133,400 acre-feet per year, and average annual yield by about 75,800 acre-feet per year. For this PDEIS, firm yield is considered equivalent to the estimated increase in the reliability of supplies during dry and critically dry periods. The majority of increased firm yield (103,800 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, increased water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effective use of these supplies may reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP5, approximately \$3.8 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 96 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities.

Conserve, Restore, and Enhance Ecosystem Resources This component includes improving shallow, warm-water fish habitat by using manzanita cleared from above the inundation zone to create structural enhancements, and planting cereal grains to treat shoreline areas. These improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Placing manzanita brush structures near the Shasta Lake shoreline would enhance the diversity of structural habitat available for the warm-water fish species that occupy Shasta Lake. Establishing vegetation also could benefit terrestrial species that inhabit the shoreline of Shasta Lake.

The lower reaches of perennial tributaries to Shasta Lake would be targeted for aquatic restoration because they provide year-round fish habitat. Native fish species require connectivity to the full range of habitats offered by Shasta Lake and its tributaries. Improved fish passage addresses the requirement to provide access and/or modify barriers to improve ecological conditions that support these native fish assemblages. Aquatic habitat improvements include enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams.

In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat are expected to

improve the complexity of aquatic habitat and its suitability for spawning and rearing. Riparian areas provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous threatened or endangered species. Riparian areas also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. Side channels can support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities CP5 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. In addition, this alternative includes construction of 18 miles of new trails and 6 trailheads to enhance recreation opportunities at Shasta Lake. As with the other alternatives, a small benefit would likely occur to the water-oriented recreation experience at Shasta Lake due to the increase in lake surface area and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,500 acres (8 percent), from 29,600 acres to about 32,100 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by raising the bottom of the flood control pool elevation and allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Objectives CP5 could also provide benefits related to flood damage reduction and water quality, similar to CP3.

Construction for CP5

Construction activities related to enlarging the reservoir under CP5 are identical to those described for CP3, and are summarized in Tables 2-23 through 2-29. Additional construction efforts would be required for the proposed spawning gravel augmentation and riparian, floodplain, and side channel habitat restoration, which are described under CP4. Construction activities associated with Shasta Lake tributary and shoreline enhancement are described below.

Shasta Lake Tributary and Shoreline Enhancement Structural enhancements associated with CP5 include placing brush structures constructed from whiteleaf manzanita (*Arctostaphylos manzanita*) in the Shasta Lake littoral zone. Because of manzanita's density, installation does not require using anchor or cabling techniques that could result in ancillary negative impacts (e.g., maintenance, hazards to boaters). The brush structures would be assembled in the drawdown zone of the reservoir in an area that would be inundated as the reservoir surface elevation rises in fall. The brush structures are expected to be about 1,800 cubic feet in size. The establishment period

would be the first year after construction; life span of the brush structures is projected to be 10 years.

Table 2-30 identifies the general area, number, and size of proposed structural enhancement locations for the main body of Shasta Lake, and the Pit, Sacramento, McCloud, Big Backbone, and Squaw arms. Selection of specific locations has been deferred so that enhancement locations are consistent with other objectives of the SLWRI. The level of proposed treatment is based on the proportion of available manzanita surrounding Shasta Lake. In general terms, these locations would incorporate available material at locations with preferred topographic features; preferred locations are coves that offer steep drawdown areas during the primary use period (spring, early summer).

Table 2-30. Proposed Structural Enhancement by Arm of Lake and by Arm

Area	Area Treated (acres)	Number of Locations
Main Body	17	595
Pit	12	420
Sacramento	43	1,505
McCloud	8	280
Big Backbone	3	105
Squaw	17	595
Total	100	3,500

Vegetative enhancements associated with CP5 include planting willows (*Salix*) to enhance nearshore fish habitat, and aerial and hand seeding of annual cereal grains to treat shoreline areas at Shasta Lake.

More than 30 acres could be available to enhance the willow recruitment adjacent to Shasta Lake. Rooted willows would be planted in draws and other moist sites, such as springs, to provide long-term live cover. The establishment period for willows would be the first year after construction; life span is projected to be 5 to 50 years. The establishment period for cereal grains would also be the first year of construction, with the life span projected to be 1 to 3 years. This approach would require native seed and nursery stock; several years of advanced preparation would be needed before planting could take place.

Table 2-31 summarizes proposed enhanced treatment with willows and native grasses by arm.

Table 2-31. Proposed Vegetative Enhancement Treatment of Lake and by Arm

Arm	Willow Planting (acres)	Native Grass Seeding (acres)
Main Body	1	2
Pit	1	4
Sacramento	7	4
McCloud	1	2
Big Backbone	3	2
Squaw	1	2
Total	14	16

Operations and Maintenance for CP5

Operations and maintenance of Shasta Dam and Reservoir under CP5 would be similar to the operations and maintenance discussed for CP3.

2.5 Comparison of Alternatives

Each of the alternatives has been evaluated against the specified objectives and four criteria of completeness, effectiveness, efficiency, and acceptability, as identified in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (WRC 1983). Evaluation of environmental impacts and mitigation measures is an important subfactor of the completeness criterion. Table 2-32 summarizes the overall potential benefits of all alternatives. The quantified benefits were based on modeling efforts that are described in several parts of the PDEIS, including Chapter 6, “Hydrology, Hydraulics, and Water Management;” Chapter 11, “Fisheries and Aquatic Resources;” Chapter 23, “Power and Energy;” the Modeling Appendix; and the Economic Valuation Appendix.

As can be seen in Table 2-32, the alternatives differ in overall benefits.

2.5.1 Completeness

Completeness is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others. Several subfactors that are important in measuring this criterion include (1) authorization, (2) spectrum of objectives being addressed, (3) reliability, (4) physical implementability, and (5) environmental effects and mitigation.

Table 2-32. Summary of Potential Features and Major Benefits of SLWRI Alternatives

Item	CP1	CP2	CP3	CP4	CP5
Raise Shasta Dam (feet)	6.5	12.5	18.5	18.5	18.5
Total Increased Storage (TAF)	256	443	634	634	634
Benefits					
Increase Anadromous Fish Survival					
Dedicated Storage (TAF)	-	-	-	378	-
Production Increase (thousand fish) ¹	366	234	607	1,199	607
Spawning Gravel Augmentation (tons) ²				10,000	10,000
Side Channel Rearing Habitat Restoration (miles)				0.8	0.8
Increase Water Supply Reliability					
Total Increased Firm Water Supplies (TAF/year) ³	76.4	105.1	133.4	76.4	133.4
Increased Firm Water Supplies NOD (TAF/year) ³	9.6	19.8	29.6	9.6	29.6
Increased Firm Water Supplies SOD (TAF/year) ³	66.8	85.3	103.8	66.8	103.8
Increased Water Use Efficiency Funding	Yes	Yes	Yes	Yes	Yes
Increased Emergency Water Supply Response Capability	Yes	Yes	Yes	Yes	Yes
Reduce Flood Damage					
Increased Reservoir Capacity for Capture of High Flood Flows	Yes	Yes	Yes	Yes	Yes
Develop Additional Hydropower Generation					
Increased Hydropower Generation (GWh/year)	42	68	96	138	96
Conserve, Restore, and Enhance Ecosystem Resources					
Shoreline Enhancement (acres)	-	-	-	-	130
Tributary Aquatic Habitat Enhancement (miles) ⁴	-	-	-	-	6
Riparian, Floodplain, and Side Channel Restoration Habitat (acres)	-	-	-	2.9	2.9
Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River	Yes	Yes	Yes	Yes	Yes
Maintain or Improve Water Quality					
Improved Delta Water Quality	Yes	Yes	Yes	Yes	Yes
Increased Delta Emergency Response Capability	Yes	Yes	Yes	Yes	Yes
Maintain and Increase Recreation					
Recreation (increased user days, thousands) ⁵	83	141	224	224	224
Modernization of Relocated Recreation Facilities	Yes	Yes	Yes	Yes	Yes

Notes:

¹ Average annual increase in juvenile Chinook salmon surviving to migrate downstream from the Red Bluff Diversion Dam. Numbers were derived from SALMOD.

² Average amount per year for 10-year period.

³ Total drought period reliability to CVP and SWP. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

⁴ Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

⁵ These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans.

Key:

- = not applicable

CP = comprehensive plan

CVP = Central Valley Project

Delta = Sacramento-San Joaquin Delta

GWh/year = gigawatt-hours per year

NOD = north of Delta

SOD = south of Delta

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre feet

The No-Action Alternative rates very low for completeness, and each of the action alternatives rates from high to very high. Two distinguishing subfactors are (1) spectrum of objectives being addressed and (2) reliability. CP1, CP2, and CP3 primarily address anadromous fish survival and water supply reliability; however, each of these alternatives indirectly contributes to each of the other objectives, with the exception of ecosystem restoration. Further, the likely reliability and certainty of each of these three alternatives to meet its intended objectives is very high. These alternatives do not significantly rely on any other actions. However, CP4 specifically focuses on anadromous fish through increasing the minimum carryover storage space in Shasta Reservoir each year, and CP5 focuses on additional ecosystem restoration and recreation. With both CP4 and CP5, O&M requirements would increase. Accordingly, overall reliability would be reduced for each alternative.

Another significant subfactor is environmental effects and mitigation. Anticipated impacts are generally comparable between alternatives; some impacts are exacerbated by larger dam raises and the associated scale of those impacts, such as a prolonged construction period and increased area of inundation around Shasta Lake. Generally, the impacts would be mitigable with the measures identified in subsequent chapters. Some impacts, including short-term generation of construction-related emissions in excess of Shasta County Air Quality Management District thresholds, and the temporary exceedence of Shasta County noise level standards, could remain significant and unavoidable despite mitigation measures. Altered flow regimes, changes to the areas inundated by the Sacramento River and Shasta Lake, and disturbances associated with construction activities have the potential to impact environmental resources. These impacts would be largely mitigable. A detailed description and assessment of the impacts to environmental resources, and appropriate mitigation measures, are described by resource area in Chapters 4 through 25.

2.5.2 Effectiveness

Effectiveness is the extent to which an alternative alleviates problems and achieves objectives. For the primary objective of anadromous fish survival, two major relative ranking factors were considered: (1) increasing salmon survival (decreasing salmon mortality) and (2) increasing habitat for spawning. For the primary objective of increasing water supply reliability, ranking was based on the relative amount of new drought period (firm) yield that could be derived from each comprehensive plan. For the secondary objectives, four ranking factors were considered: (1) whether a comprehensive plan included ecosystem restoration, (2) potential to affect flood peaks downstream from Keswick Dam, (3) potential to increase net power generation, and (4) amount of increased recreation opportunities at Shasta Lake.

Comprehensive plans with the greatest effectiveness in meeting objectives appear, at this time, to be CP3, CP 4, and CP5. This is primarily because CP3 and CP5 would provide the largest contribution toward water supply reliability

and CP4 would provide the largest contribution toward anadromous fish survival. All three plans provide benefits to ecosystem restoration (via improved fisheries conditions), flood damage reduction, hydropower generation, recreation, and water quality.

2.5.3 Efficiency

Efficiency is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives consistent with protecting the Nation's environment. The relative rankings for efficiency are based primarily on likely net benefits obtained under each plan. Assuming the cost of water supplies increases at the same rate as inflation, CP1, CP3, CP4, and CP5 would be economically feasible, and assuming the cost of water supplies increases at 2 percent above inflation, all plans would be economically feasible. At this stage of analysis under either condition, it appears that CP4 has potential to provide the greatest net economic benefits. This is primarily because of the higher potential increase in anadromous fish survival.

2.5.4 Acceptability

Acceptability is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local government agencies, and public interest groups and individuals. This evaluation criterion will be very important following completion of the Final Feasibility Report and endorsement by a non-Federal sponsor of the comprehensive plan recommended for implementation. It appears that all of the comprehensive plans would be similarly ranked for this criterion. Each of the plans needs to be coordinated with other agencies and public interests.

2.6 Preferred Alternative and Rationale for Selection

This section provides a summary of the comparison of alternatives, identifies the likely preferred alternative, and provides the rationale for selection.

2.6.1 Summary of Comparison

Each of the comprehensive plans is estimated to be complete, each appears to be effective in achieving its intended objectives, and each is cost-efficient. The three comprehensive plans involving a dam raise of 18.5 feet (CP3, CP4, and CP5) best address the planning objectives. This is primarily because of (1) high certainty (completeness) that the plans could achieve their intended benefits, and (2) relatively high effectiveness and economic efficiency.

2.6.2 Rationale for Plan Selection

A plan recommending Federal action should be the plan that best addresses the targeted water resources problems considering public benefits relative to costs. The basis for selecting the recommended plan is to be fully reported and documented, including the criteria and considerations used in selecting a recommended course of action by the Federal Government. It is recognized that

most of the activities pursued by the Federal Government will require assessing trade-offs by decision makers and that in many cases, the final decision will require judgment regarding the appropriate extent of monetized and nonmonetized effects.

The needed rationale to support Federal investment in water resources projects is described in the 2009 *Draft Proposed National Objectives, Principles, and Standards for Water and Related Resources Implementation Studies* (CEQ):

The presentations shall summarize and explain the decision rationale leading from the identification of need through the recommendation of a specific alternative. This shall include the steps, basic assumptions, analysis methods and results, criteria and results of various screenings and selections of alternatives, peer review proceedings and results, and the supporting reasons for other decisions necessary to execute the planning process. The information shall enable the public to understand the decision rationale, confirm the supporting analyses and findings, and develop their own fully-informed opinions and/or decisions regarding the validity of the study and its recommendations.

Opportunities shall be provided for public reaction and input prior to key study decisions, particularly the tentative and final selection of recommended plans. The above information shall be presented in a decision document or documents, and made available to the public in draft and final forms. The document(s) shall demonstrate compliance with the National Environmental Policy Act (NEPA) and other pertinent Federal statutes and authorities.

At this stage of the NEPA and Federal planning processes, the potential effects of the alternative plans have been evaluated and compared based on established criteria. As a result, alternatives involving an 18.5-foot raise of Shasta Dam appear to have the greatest environmental benefits, although no environmentally preferable alternative has been selected. It is recognized that further refinement and changes may occur to the comprehensive plans with changes in CVP/SWP operational conditions, and after updates to modeling studies and input from agencies, stakeholders, and the public. The results of these updated studies will be incorporated into the Draft EIS and other future SLWRI documents.

Ultimately, the alternative that best meets the stated objectives and maximizes net public benefits will be identified in the Final Feasibility Report and FEIS with supporting rationale and documentation. If determined to be feasible, it is expected that the plan recommended for implementation will meet all pertinent Federal, State, and local laws, policies, regulations, and other requirements so that it may be ideally recognized as the “Environmentally Preferred Plan”

consistent with NEPA, the “NED Plan” consistent with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, the “Least Environmentally Damaging Practicable Alternative” consistent with the CWA, and the “Environmentally Superior Alternative” consistent with CEQA. Then, responsible Federal, State, and local decision makers will decide whether to approve, authorize, and/or appropriate funding for implementation of the preferred alternative.